

Quality Assurance Project Plan Lower Aquifer Groundwater Monitoring Wyckoff/Eagle Harbor Superfund Site Bainbridge Island, Washington

Prepared for
**U.S. Environmental Protection Agency
Region 10**



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Prepared by
ch2m.

Task Order No. 080

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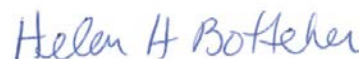
Title and Approval Sheet
Quality Assurance Project Plan
Lower Aquifer Groundwater Monitoring Wyckoff/Eagle Harbor

Plan approvals:

Ken Scheffler



Helen Bottcher



EPA Region 10 Task Order Project Officer

6/29/16

CH2M Project Manager

Mark Cichy



Donald M. Brown



6/29/16

EPA Regional Quality Assurance Manager

CH2M Quality Assurance Officer

Distribution List

Name/Organization	Address/Phone/Email	Document Distribution
Helen Bottcher EPA Task Order Project Officer	EPA Region 10 1200 Sixth Avenue, ECL-113 Seattle, WA 98101 (206) 553-6069 bottcher.helen@epa.gov	QAPP (e-copy only) EPA MEL Final Data (E-copy)
Donald M. Brown EPA Regional Quality Assurance Manager	EPA Region 10 1200 Sixth Avenue, OEA-095 Seattle, WA 98101 (206) 553-0717 Brown.DonaldM@epa.gov	QAPP (e-copy only)
Don Matheny EPA Quality Assurance Chemist CLP Project Officer	EPA Region 10 1200 Sixth Avenue, OEA-095 Seattle, WA 98101 (206) 553-553-2599 Matheny.Don@epa.gov	QAPP (e-copy only)
Jennifer Crawford EPA Quality Assurance Chemist EPA Regional Sample Control Center Coordinator	EPA Region 10 1200 Sixth Avenue, OEA-095 Seattle, WA 98101 (206) 553-6261 Crawford.Jennifer@epa.gov	QAPP (e-copy only)
Ken Scheffler CH2M Project Manager	1100 112th Avenue NE, Suite 500 Bellevue, WA 98004-4504 (206) 682-0074 Ken.Scheffler@ch2m.com	QAPP (e-copy only) EPA MEL Final Data (E-copy)
Mark Cichy CH2M Quality Assurance Officer	2525 Airpark Drive Redding, CA 96001 (530) 229-3274 mark.cichy@ch2m.com	QAPP (e-copy only) EPA MEL Final Data (E-copy)
Scott McKinley CH2M Task Lead/Hydrogeologist	1100 NE Circle Boulevard, Suite 300 Corvallis, OR 97330 (541) 768-3514 scott.mckinley@ch2m.com	QAPP (e-copy only) EPA MEL Final Data (E-copy)
Nicole Badon CH2M Field Team Leader	1100 112th Avenue NE, Suite 500 Bellevue, WA 98004-4504 (425) 233-4405 Nicole.Badon@ch2m.com	QAPP (e-copy only) EPA MEL Final Data (E-copy)
Leslie Karlewicz CH2M Data Base Manager	1100 112th Avenue NE, Suite 500 Bellevue, WA 98004 (425) 233-3039 Leslie.Karlewicz@ch2m.com	QAPP (e-copy only) EPA MEL Final Data (E-copy)

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Acronyms and Abbreviations

µg/L	micrograms per liter
%R	percent recovery
AES	Architect and Engineering Services
bgs	below ground surface
CERCLA	Comprehensive Environmental Response Action and Liability Act
CH2M	CH2M HILL Inc.
CLP	Contract Laboratory Program
CSM	conceptual site model
COC	chain-of-custody or contaminant of concern
CUL	cleanup level
DNAPL	dense nonaqueous phase liquid
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FASTAC	Field and Analytical Services Teaming Advisory Committee
FD	field duplicate
FPA	former process area
FFS	focused feasibility study
FTL	Field Team Leader
GWTP	groundwater treatment plant
HSP	Health and Safety Plan
IDW	investigation-derived waste
LNAPL	light nonaqueous phase liquid
MDL	method detection limit
MEL	Manchester Environmental Laboratory
mg/L	milligrams per liter
MRL	method reporting limit
MS	matrix spike
mS/cm	millisiemens per centimeter
MSD	matrix spike duplicate
MTCA	Model Toxics Control Act
mV	millivolt
NA	not applicable
NAPL	nonaqueous phase liquid
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCP	pentachlorophenol
PM	Project Manager
PO	Project Officer
PPE	personal protective equipment
PSQ	principal study question
QA	quality assurance

QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
R10	EPA Region 10
RAO	remedial action objective
ROD	Record of Decision
RPD	relative percent difference
RSCC	Regional Sample Control Center
RSD	relative standard deviation
RTL	Review Team Leader
S2BVE	Stage 2B electronic validation
S4VEM	Stage 4 electronic and manual data validation
SSDG	Sample Delivery Group
site	Wyckoff/Eagle Harbor Superfund Site
SMO	Sample Management Office
SOP	standard operating procedure
SVOC	semivolatile organic compound
TDS	total dissolved solids
TO	Task Order
TOPO	Task Order Project Officer
TPH	total petroleum hydrocarbons
TR	traffic report
USACE	U.S. Army Corps of Engineers

SECTION 1

Introduction

This Quality Assurance Project Plan (QAPP) presents the policies, organizations, objectives, and functional activities and procedures for Lower Aquifer groundwater monitoring being conducted by the U.S. Environmental Protection Agency (EPA) at the Wyckoff/Eagle Harbor Superfund Site (the site) on Bainbridge Island, Washington. The purpose of the Lower Aquifer groundwater monitoring program is to determine the following: 1) the absence and/or presence of nonaqueous-phase liquid (NAPL) and 2) to assess the nature and extent of site-related contaminants in Lower Aquifer groundwater within the site's Soil and Groundwater Operable Units (OUs). Data gathered as part of this monitoring program will be used to assess the effectiveness of the current and future Upper Aquifer response actions to protect the Lower Aquifer from further degradation. The QAPP and its supporting documents, found in [Appendix A](#) (Data Quality Objectives), [Appendix B](#) (Field Procedures), and [Appendix C](#) (Site-Specific Data Management Plan), have been developed to document the type and quality of data needed for environmental decisions, and the associated documentation to support the QAPP procedures.

The QAPP follows EPA guidelines contained in *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5* (EPA, 2002a), and *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5* (EPA, 2001; reissued 2006). The contents of the QAPP also meet the *Uniform Federal Policy for Quality Assurance Project Plans* (EPA, 2005). QAPP development, review, approval, and implementation is part of EPA's mandatory quality system, which requires all organizations to develop and operate management structures and processes to ensure that data used in agency decisions are of the type and quality needed for their intended use.

This document is organized as follows:

- **Section 1—Introduction**, provides the report purpose and organization.
- **Section 2—Project Management (EPA Group A)**, provides a summary-level description of the project and task organization; background and problem definition; work tasks and project schedule; quality and objectives criteria; special training and certifications; and documents and records.
- **Section 3—Data Generation and Acquisition (EPA Group B)**, describes the sampling design; sampling methods; sample handling and custody; analytical methods; quality control (QC); instrument and equipment testing, inspection and maintenance; instrument and equipment calibration and frequency, inspection and acceptance of supplies and consumables; nondirect measurements; and data management.
- **Section 4—Assessment and Oversight (EPA Group C)**, describes assessment, oversight, and reports to management.
- **Section 5—Data Validation and Usability (EPA Group D)**, introduces the concepts of data review, verification, and validation; describes verification and validation methods; and explains reconciliation with user requirements.
- **Section 6—References**, provides a list of references used in this document.

In addition to the sections summarized above, this QAPP contains the following appended materials:

- **Appendix A—Data Quality Objectives**
- **Appendix B—Field Procedures**
- **Appendix C—Site-Specific Data Management Plan**

Project Management (EPA Group A)

2.1 Project and Task Organization (A4)

Task order (TO) 080 for this project was issued pursuant to EPA Region 6 Remedial Action Contract No. EP-W-06-021. The TO is managed by the CH2M HILL Inc. (CH2M) Project Manager (PM), who works directly with the EPA TO Project Officer (PO) (TOPO) to accomplish the work. The PM manages the TO financial, scheduling, and technical aspects. The key people involved in interfacing with the PM are the EPA TOPO and the CH2M Quality Assurance Officer (QAO), Review Team Leader (RTL), Hydrogeologic Task Lead, and the Field Team Leader (FTL).

The project organization and lines of authority for CH2M staff are illustrated on [Figure 2-1](#). The data flow is shown on [Figure 2-2](#). The data for this TO include both field measurements and laboratory analyses. [Figure 2-1](#) shows both EPA and CH2M technical and quality assurance (QA) personnel. The organizational functions shown are consistent with the Architect and Engineering Services (AES) 10 Program Plan (*EPA Management Plans and Standard Operating Procedures for Region 10 Architect Engineering Services, Contract Solicitation No. PR-R7-02-10217* [EPA, 2003a and updates]). The AES 10 Program Plan provides additional details for these organizational functions.

The following additional organizational guidelines apply:

- The review team (led by the RTL) and the QAO will review project planning documents, data evaluation, and deliverables. The primary responsibility for project quality rests with the PM, and independent QC is provided by the RTL and QAO.
- The field team will implement this QAPP and Health and Safety Plan (HSP). The site safety coordinator is responsible for adherence to the HSP and field decontamination procedures. The entire field effort is directed by the FTL. Field team responsibilities are further described in [Appendix B](#).
- The subcontract administrator will procure subcontracts for EPA's Remedial Action Contract projects under federal acquisition regulations and will be the primary interface with subcontractors. Subcontractors may be used on this TO for laboratory analyses depending on EPA regional laboratory or CLP capacity and analyte capability.
- Where QA problems or deficiencies requiring special action are uncovered, the PM, RTL, and QAO will identify the appropriate corrective action to be initiated by the FTL.
- EPA Region 10 (R10) adheres to a national EPA Field and Analytical Services Teaming Advisory Committee (FASTAC) strategy for procurement of all Superfund analytical services. FASTAC consists of EPA Headquarters, Regional Superfund Program staff, and Research, Science, and Technology managers. The FASTAC developed a "decision tree" analytical strategy in 1998 which has been implemented in every EPA region. According to the *Region 10 Quality Management Plan* (EPA, 2014a), analytical services requests are funneled through the Regional Sample Control Center (RSCC) Coordinator who selects the analytical vehicle according to the following order:
 - Tier 1—EPA Regional Laboratory and Environmental Services Assistance Team Contract
 - Tier 2—National Analytical Services Contracts (Contract Laboratory Program [CLP])¹
 - Tier 3—Region-Specific Analytical Services Contracts
 - Tier 4—Analytical Services Interagency Agreements (IAGs) and Field Contracts/Subcontracts

¹ Information about the EPA CLP may be found on the CLP Web site: <http://www.epa.gov/superfund/programs/clp>.

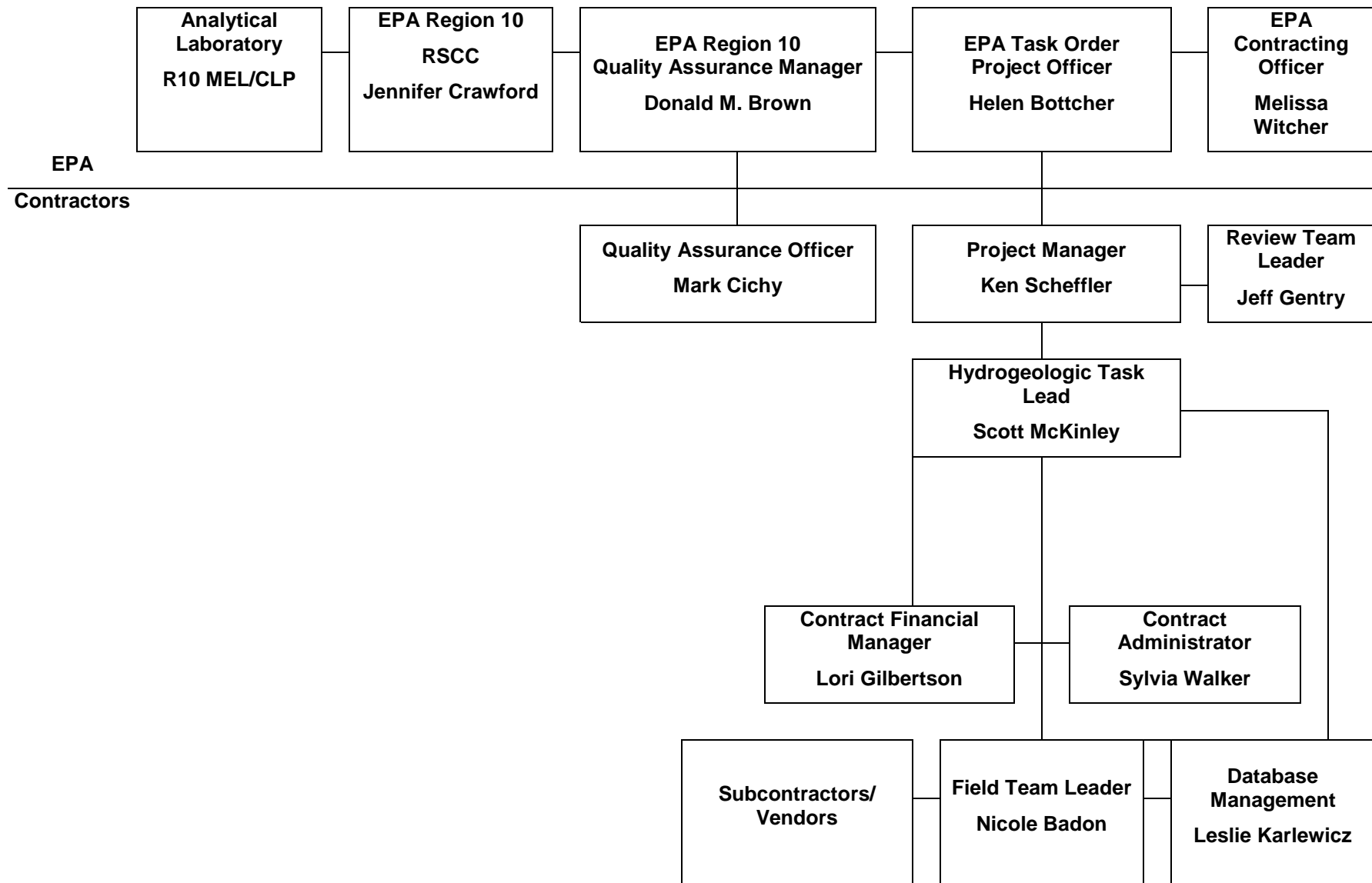


FIGURE 2-1
Project Organization and Lines of Authority

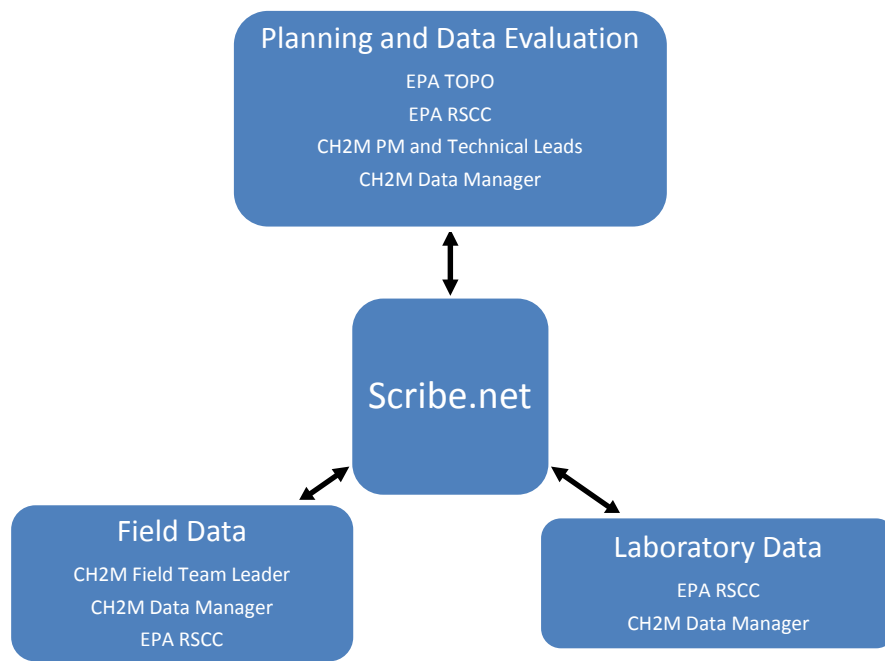


FIGURE 2-2
Data Flow Summary

- A QAPP and R10 Analytical Services Request Form are required for the RSCC to begin laboratory coordination. The EPA R10 laboratory—Manchester Environmental Laboratory (MEL)—is offered first right of refusal before proceeding to Tier 2. RSCC laboratory coordination occurs after QAPP development. Therefore, laboratory and analytical specifics throughout the QAPP must be applicable to either the EPA R10 MEL or a laboratory within the EPA CLP, because the laboratory assignment is unknown during the planning process. Laboratories are required to meet the analytical requirements set forth in this QAPP for methodology, reporting limits, QC, and data management. The field and laboratory data flow is presented in [Figure 2-2](#).
- The EPA RSCC is responsible for both CLP and EPA MEL coordination. The RSCC works with the EPA Regional Quality Assurance Manager, the region’s CLP PO, and the project’s PMs in resolving laboratory and field QA issues and laboratory scheduling. The RSCC provides the regional sample tracking numbers, sample tags, custody seals, and other CLP-required chain-of-custody (COC) documentation.

2.2 Problem Definition and Background (A5)

2.2.1 Background

The Wyckoff/Eagle Harbor Superfund Site is located on the east side of Bainbridge Island, Kitsap County, Washington. The site encompasses the contaminated areas of Eagle Harbor and adjoining uplands of the former Wyckoff wood-treating facility. The Superfund Site is divided into four OUs:

- **East Harbor OU1**—subtidal and intertidal sediments in Eagle Harbor adjacent to Wyckoff Point
- **Soil OU2**—surface and unsaturated subsurface soil in the former Wyckoff wood-treating process and storage area
- **West Harbor OU3**—sediments and uplands of former shipyard
- **Groundwater OU4**—groundwater and soil in the saturated zone beneath Soil OU2.

The Soil and Groundwater OUs comprise the approximately 18-acre area affected by releases of wood treating chemicals during the 85-year operating history of the Wyckoff facility. The Former Process Area (FPA) is an approximate 8-acre portion of the Soil and Groundwater OUs where wood treatment operations were primarily

conducted ([Figure 2-3](#)) and where large volumes of subsurface NAPL, including dense NAPL (DNAPL) and light NAPL (LNAPL), have been observed in wells and borings.

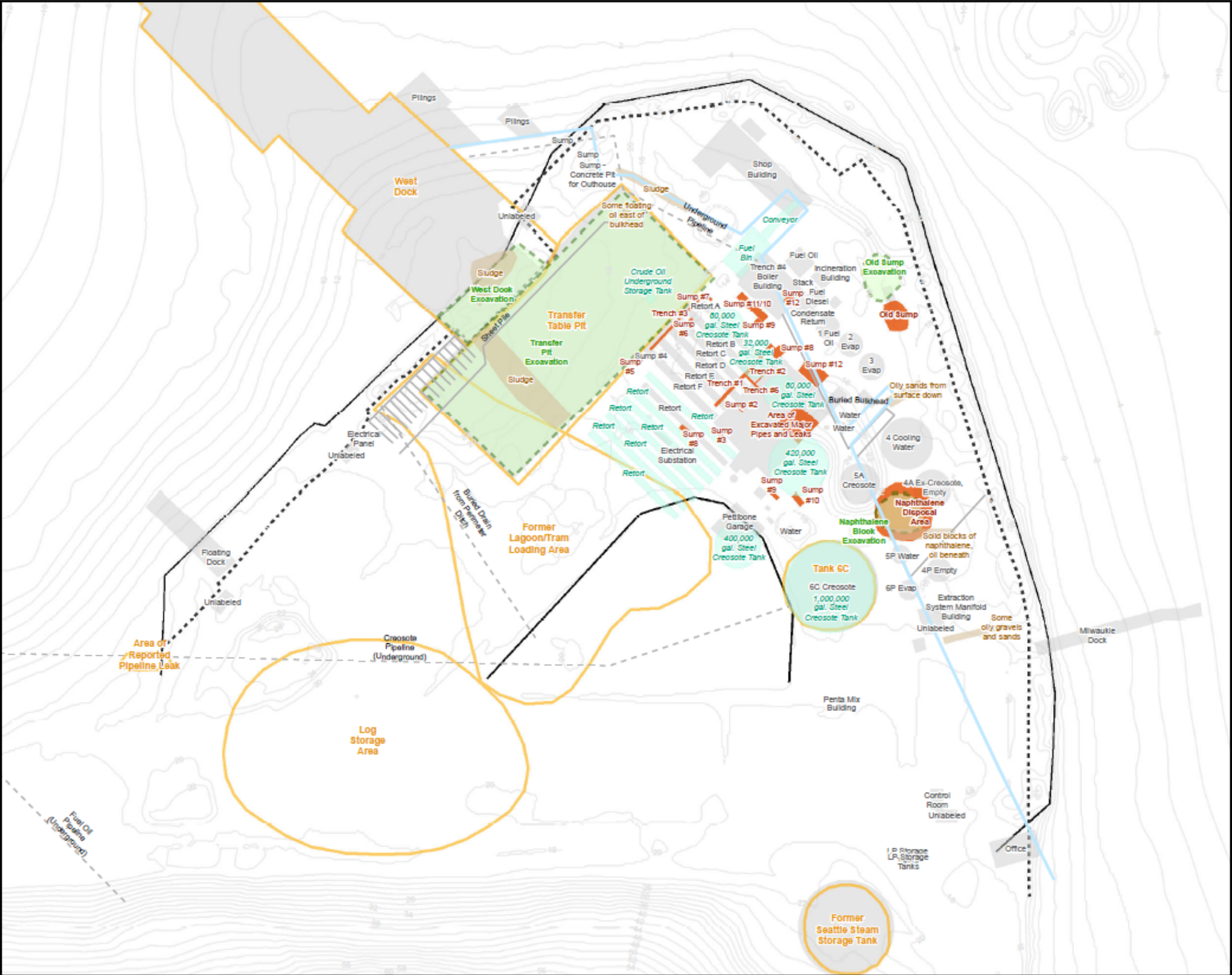
In February 2000, EPA issued the OU2 and OU4 Record of Decision (2000 ROD; EPA, 2000). The selected remedy, thermal remediation, included a number of components designed to achieve substantial risk reduction by cutting off subsurface contaminant migration pathways and treating the principal threat at the Site (NAPL) using thermal technology. A thermal remediation pilot study was conducted between October 2002 and April 2003. Numerous technical difficulties were encountered and it was determined that cleanup objectives could not be met using this technology.

The 2000 ROD identified a contingent remedy to be implemented should the thermal remediation pilot test did not achieve its performance objectives. The contingent remedy—containment—is in operation today and includes the following components:

- **Groundwater extraction and treatment**—This includes eight recovery wells screened in the Upper Aquifer. Pumps installed in these wells draw groundwater and NAPL away from the site perimeter and in toward the extraction wells. The groundwater and NAPL recovered from the extraction wells are treated in the onsite groundwater treatment plant (GWTP).
- **Sheetpile wall**—A 1,870-foot-long steel sheetpile wall was constructed around the shoreline of the FPA to prevent potential flow of NAPL and dissolved phase contaminants from the Site’s Upper Aquifer to Eagle Harbor and Puget Sound.
- **Long-term monitoring**—Water levels at 10 Upper and Lower Aquifer well pairs are continuously measured and the data evaluated quarterly to confirm that an upward vertical hydraulic gradient from the Lower Aquifer to the Upper Aquifer is maintained in the FPA. Lower Aquifer groundwater sampling, which is the subject of this QAPP, is performed on an annual basis. Upper Aquifer groundwater sampling is performed periodically with the last sampling event completed in 2014.
- **Institutional and engineering controls**—Engineering controls (e.g., fencing) have been implemented to prevent contact with contaminated soil while institutional controls prevent groundwater withdrawals except for monitoring and remediation purposes.

In 2016, EPA completed the *Non-Aqueous Phase Liquid Focused Feasibility Study for the Soil and Groundwater Operable Units (OU2/OU4) Wyckoff/Eagle Harbor Superfund Site, Bainbridge Island, WA*, (CH2M, 2016). The purpose for the focused feasibility study (FFS) was to identify, develop, and evaluate alternative response actions for addressing NAPL present in the Upper Aquifer. Based on information presented in the FFS, EPA intends to issue a Proposed Plan and Comprehensive Environmental Response Action and Liability Act (CERCLA) Decision Document to modify the current remedy.

In the 2000 ROD, a remedial action objective (RAO) to “Protect the groundwater outside the FPA and in the Lower Aquifer, which are potential drinking water sources” was established. In the 2016 FFS, a RAO to “Prevent further degradation of the Lower Aquifer” was defined. Therefore, to assess the effectiveness of the current remedy and future source control response actions to achieve these RAOs, Lower Aquifer groundwater monitoring must be performed.



LEGEND

- Historic Features
- Historic Features Identified from 1917 Sandborn Map
- Site Remediation Excavation Performed in 1992 through 1994
- Potential Primary NAPL Sources (Sumps, Trenches, and other features with observed contamination)
- Potential Secondary NAPL Source Areas
- Trenching and other features of Interest Identified in April 1989 Map
- Facility Shoreline as of 1917
- Bulk Head Prior to Current Sheet Pile Wall
- Current Sheet Pile Wall
- Ground Surface Contours (2 ft CI, ft MLLW)

Sources:
 Bulk Head Prior to Current Sheet Pile Wall digitized from current sheet pile wall design drawings (USACE, 2000)
 Some sumps and trenches were digitized from "Figure 1 Site Location" (Environment and Ecology, 1995)
 Sumps and Trenches were digitized from "Figure B Area 1 Trenches and Sumps"; "Figure C Area 2 Drums, Sumps, 7 Tanks"; "Figure D Area 3 Containers, Drums, Sumps, Tanks & Trenches" (Environment and Ecology, 1995)
 Secondary NAPL Source Locations digitized from "Figure 2-1 Wycoff Site Vicinity Map" (CH2M HILL, 1993)
 Trenching observations digitized from 1989 hand markup.
 Prioritizing of source areas conducted 2012.

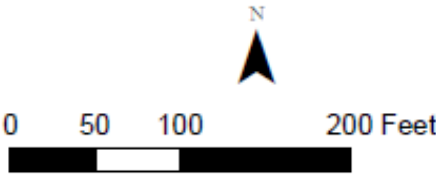


Figure 2-3
 Project Study Area and Potential Sources
 Wycoff/Eagle Harbor Superfund Site

2.2.2 Problem Definition

The systematic planning process and generation of data quality objectives (DQO) for the Lower Aquifer groundwater monitoring program are summarized in [Appendix A](#), Data Quality Objectives. The primary objective for the monitoring program is to collect the data necessary to determine whether current and future Upper Aquifer remedial actions are protecting the Lower Aquifer from further degradation. A secondary objective is to develop the information needed to support selection of a final remedy for the Lower Aquifer in a future CERCLA decision document. The following problem statements were developed based on these objectives:

- Determine NAPL presence, thickness, and distribution in the Lower Aquifer.
- Determine general water quality for use in defining potable and nonpotable zones and evaluating spatial and temporal variations in the boundary between the two zones.
- Minimize the effects of tidal fluctuation and saltwater intrusion on Lower Aquifer groundwater quality sample representativeness.
- Measure dissolved-phase contaminant concentrations and distribution to establish a baseline for comparison to future monitoring results to confirm that no further degradation has occurred.
- Dispose of investigation-derived waste (IDW) to prevent areas of new contamination.

2.3 Project Description (A6)

2.3.1 Work Tasks

The work activities to be performed under this QAPP include the following:

- Determine NAPL absence, presence, and thickness in existing Lower Aquifer monitoring wells.
- Sample Lower Aquifer groundwater samples from existing monitoring wells with laboratory analysis for the contaminants of concern (COC) and potable and nonpotable water chemistry.

The well locations are shown on [Figure 2-4](#).

2.3.2 Project Schedule

Activities listed in this QAPP are expected to begin July 2016 and continue annually until a final remedy for the Lower Aquifer is selected. This QAPP will be updated at least every 5 years or whenever there is a change in sampling or analytical methods. Groundwater sample collection is expected to require up to 5 days. A detailed sampling schedule will be provided for each event at least 4 weeks prior to allow for lab scheduling.

2.4 Quality Objectives and Criteria (A7)

2.4.1 Project Quality Objectives

Project-specific technical systematic planning has been carried out through the DQO process and planning tool (EPA, 2006) to meet decision-maker and data user needs for each activity. [Appendix A](#) presents the DQO process findings.

The data needs as determined through the DQO process are presented in [Table 2-1](#) (located at the end of this section). This table lists the specific analytes, data uses, data users, and project required action levels. The listed action level is the lowest regulatory, risk, or technical criterion identified for the specific analyte. The various criteria that were evaluated are described in [Appendix A](#). The required action levels shown in [Table 2-1](#) were considered in selecting appropriate analytical methods. The selected analytical methods and associated laboratory and field analytical reporting limits are shown in [Table 2-2](#) (located at the end of this section). The project-required limits and action levels ([Table 2-1](#)) and the analytical reporting limits ([Table 2-2](#)) are compared in [Appendix A](#). The selected methods are appropriate for this study. Where sample-specific reporting limits are higher than needed limits, the project team will use method detection limits (MDLs), as needed and available, for project decisions.

2.4.2 Measurement Performance Criteria

The QA objective of this plan is to identify procedures and criteria that will provide data of known and appropriate quality for the needs identified in Section 2.3.1. Data quality is assessed by representativeness, comparability, accuracy, precision, and completeness. These parameters, the applicable procedures, and level-of-effort are described in the following paragraphs.

The applicable QC procedures, quantitative target limits, and level-of-effort for assessing data quality are dictated by the intended use of the data and nature of the analytical methods. Analytical parameters, analytical methods, applicable detection levels, analytical precision, accuracy, and completeness in alignment with needs identified in Section 2.3.1 are presented in [Table 2-2](#). Analytical methods and QC procedures are further detailed in Section 3.

Reporting detection levels and target detection limits listed in [Table 2-2](#) are laboratory method reporting limits (MRLs), equivalent to MEL Reporting Limits or EPA CLP contract-required levels. “Target” implies that final sample detection levels might be higher because of sample matrix effects. For solid matrices (soil, sediment), if any, sample reporting limits will be elevated as a function of sample moisture since concentrations are reported on a dry weight basis. Detection levels for the individual samples will be reported in the final data. As described in Section 2.3.1, some of the reporting limits might be higher than the needed limits because of a matrix effect, dilutions, preparation and digestion weight (solids), or because no practicable methodology for lower detection is available. Laboratory-specific MDLs are significantly below reporting levels. Where reporting limits are higher than regulatory limits, the project team will use sample-specific reported MDLs, as needed and available, for project decisions. Values below the reporting are an estimate and will be qualified for proper use. MEL does not standardly report detected values between the MRL and MDL; any detects below the MRL will be reported at the MRL with a “U” qualifier.

Following are definitions and levels of effort for the data assessment parameters:

- **Representativeness** is a measure of how closely the results reflect the actual concentration or distribution of the chemical compounds in the matrix samples. Sampling plan design, sampling techniques, and sample-handling protocols (e.g., for storage, preservation, and transportation) have been developed and are discussed in Appendices A and B. The proposed documentation will establish that protocols have been followed and sample identification and integrity ensured.
- **Comparability** expresses the confidence with which one data set can be compared to another. Data comparability will be maintained using defined procedures and the use of consistent methods and consistent units. Actual detection limits will depend on the sample matrix and will be reported as defined for the specific samples.
- **Accuracy** is an assessment of the closeness of the measured value to the true value. For samples, accuracy of chemical test results is assessed by spiking samples and blanks with known standards and establishing the average recovery. For a matrix spike (MS), known amounts of a standard compound identical to the compounds being measured are added to the sample. A quantitative definition of average recovery accuracy is given in Section 5.3. Accuracy is a combination of random error (precision) and systematic error (bias), introduced during sampling and analytical operations. Bias is the systematic distortion of a measurement process that causes errors in one direction, so that the expected sample measurement is always greater or lesser to the same degree than the sample’s true value. The accuracy of measurement data will be determined by calculating the recoveries from the analysis of standard reference materials and laboratory and laboratory fortified samples (MSs). Accuracy measurement will be carried out with a minimum frequency of 1 in 20 samples analyzed.
- **Precision** of the data is a measure of the data spread, when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference; a quantitative definition is given in Section 5.3. The level of effort for precision measurements will be a minimum of 1 in 20 samples.

Completeness is a measure of the amount of valid data obtained from the analytical measurement system and the complete implementation of defined field procedures. The quantitative definition of completeness is



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- Lower Aquifer Well
- Fence
- Sheetpile Wall
- Roads
- Buildings
- Concrete Slab
- Structures
- * Vertical Gradient Monitoring Location
- Wells Identified for Annual Sampling Beginning in 2016
- Wells Identified for Annual Sampling Beginning in 2016 where DNAPL was Observed in 2012/2014

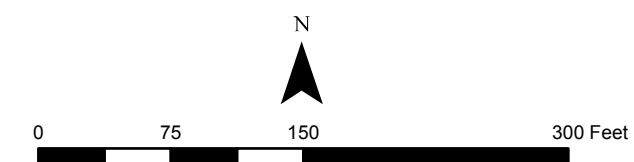


FIGURE 2-4
Lower Aquifer Monitoring Well Sample Locations
Wyckoff/Eagle Harbor Superfund Site
Bainbridge Island, WA

- given in Section 5.3. The target completeness objective will be 90 percent; the actual completeness might vary depending on the intrinsic nature of the samples and the ability to assess sample locations and collect field samples. The completeness of the data will be assessed during QC reviews.
- **Sensitivity** is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. It is important to be able to detect the target analytes at the levels of interest. Sensitivity requirements include establishing various limits such as calibration requirements and method detection limits (MDL). The sensitivity limits are listed as MRL objectives in Table 2-1 and Table A-1.

2.5 Special Training and Certification (A8)

All project staff working on the site will be trained in health and safety and follow requirements specified in the project's HSP. The HSP describes the specialized training required for personnel on this project and the documentation and tracking of this training. A copy of the HSP is maintained at the project site.

2.6 Documents and Records (A9)

Project systematic planning through the DQO is documented in [Appendix A](#) of this QAPP. Required field documentation and records are described in [Appendix B](#). Laboratory documentation will be provided in accordance with methods and QA protocols listed in Sections 3.4 and 3.5 of this QAPP and with EPA Regional Laboratory-specific standard operating procedures (SOPs). Overall project documentation will be prepared in accordance with the EPA Region 10 AES Program Plan (EPA, 2003a and updates). Sample management including COCs will be documented in Scribe, in accordance with requirements specified in the R10 Data Management Plan (2014).

TABLE 2-1
Data Needs And Uses

Matrix/ Parameters	Analyte	Data Use	Data User	ROD CUL (µg/L) ^a	MTCA B (µg/L) ^b	Lowest Project Action Level (µg/L unless unit shown)	Target Reporting Limits per Lowest Project Criteria ^c (µg/L unless unit shown)
NAPL	Thickness	Determine absence/presence, and distribution	Site investigators, hydrogeologists, and remedial technologists	Not specified	Site-specific determination	0.05 foot	0.05 foot
Water Quality (anions and cations)	Calcium	Characterize concentrations in Lower Aquifer, calculate anion- cation balance and charge balance error, and refine the CSM; specifically to assess presence or absence of saltwater in groundwater samples	Site investigators, hydrogeologists, and remedial technologists	None	None	500	Standard MRLs
	Magnesium					500	
	Potassium					500	
	Sodium					500	
	Chloride					60	
	Sulfate					300	
	Alkalinity					5,000	
	Nitrate					50	
	Iron (total and dissolved)					100	
	Manganese (total and dissolved)					2	
Water Quality	TDS	Characterize concentrations in Lower Aquifer, determine potable/non-potable zones, correlate with field salinity measurements, and refine the CSM.	Site investigators, hydrogeologists, and remedial technologists	None	None	20,000	Standard MRLs
Water Quality (COCs)	2-methylnaphthalene	Characterize dissolved phase concentrations outside NAPL source zones, refine the CSM, and support alternatives evaluation.	Site investigators, hydrogeologists, and remedial technologists	None	None	NA	Standard MRLs
	Acenaphthene			3	960	3	1.5
	Acenaphthylene			None	None	NA	Standard MRLs
	Anthracene			9	4,800	9	4.5
	Benzo(a)anthracene			0.0296	0.12	0.0296	0.01
	Benzo(a)pyrene			0.0296	0.012	0.0296	0.01
	Benzo(b)fluoranthene			0.0296	0.12	0.0296	0.01
	Benzo(g,h,i)perylene			None	None	NA	Standard MRLs

TABLE 2-1
Data Needs And Uses

Matrix/ Parameters	Analyte	Data Use	Data User	ROD CUL (µg/L) ^a	MTCA B (µg/L) ^b	Lowest Project Action Level (µg/L unless unit shown)	Target Reporting Limits per Lowest Project Criteria ^c (µg/L unless unit shown)
	Benzo(k)fluoranthene			0.0296	1.2	0.0296	0.01
	Chrysene			0.0296	12	0.0296	0.01
	Dibenz(a,h)anthracene			0.007	0.012	0.007	Less than 0.0035
	Fluoranthene			3	640	3	1.5
	Fluorene			3	640	3	1.5
	Indeno(1,2,3-cd)pyrene			0.030	0.12	0.030	0.01
	Naphthalene			83	160	83	41
	Pentachlorophenol			4.9	0.219	0.219	0.1
	Phenanthrene			None	None	NA	Standard MRLs
	Pyrene			15	480	15	7.5
Water Quality/ Field Parameters	Salinity	Characterize dissolved phase concentrations outside NAPL source zones, refine the CSM, and support alternatives evaluation.	Site investigators, hydrogeologists, and remedial technologists	NA	NA	0.01 percent	0.01 percent
	Dissolved oxygen					0.1 mg/L	0.1 mg/L
	pH			NA	NA	0.1 S.U.	0.1 S.U.
	Conductivity			NA	NA	1 mS/cm	1 mS/cm
	Redox Potential			NA	NA	1 mV	1 mV
	Temperature			NA	NA	0.1 °C	0.1 °C
	Depth to water			NA	NA	0.01 foot	0.01 foot

Notes:

^a CUL specified in Table 13 in the 2000 ROD (EPA, 2000).^b Groundwater MTCA B value from the CLARC database (September 2015).^c Approximately one-half of the lowest project action level

°C	degrees Celsius	CSM	conceptual site model
µg/L	micrograms per liter	CUL	clean-up level
CLARC	Cleanup Levels and Risk Calculation	mg/L	milligrams per liter
COC	contaminant of concern	MRL	method reporting limit

mS/cm	millisiemens per centimeter
MTCA	Model Toxics Control Act
mV	millivolt
NA	not applicable

NAPL	nonaqueous-phase liquid
ROD	Record of Decision
S.U.	standard unit
TDS	total dissolved solids

TABLE 2-2
Measurement Performance Criteria

Matrix/Parameter	Method	Project Target Reporting Limit per Table 2-1 (µg/L unless unit shown)	Laboratory Target Standard Reporting Limit (µg/L unless unit shown)	Accuracy (percent recovery)	Precision (relative percent deviation)	Completeness (percent)
Groundwater/General Chemistry						
Calcium	EPA 6010B or CLP SOW	Standard Method RL	500	70 to 130	±30	90
Magnesium	EPA 6010B or CLP SOW	Standard Method RL	500	70 to 130	±30	90
Potassium	EPA 6010B or CLP SOW	Standard Method RL	500	70 to 130	±30	90
Sodium	EPA 6010B or CLP SOW	Standard Method RL	500	70 to 130	±30	90
Chloride	EPA 300.0	Standard Method RL	60	70 to 130	±30	90
Sulfate	EPA 300.0	Standard Method RL	300	70 to 130	±30	90
Alkalinity	SM 2320B	Standard Method RL	5000	70 to 130	±30	90
Nitrate+Nitrite	EPA 353.2 ^a	Standard Method RL	50	70 to 130	±30	90
Iron (total and dissolved)	EPA 6010B or CLP SOW	Standard Method RL	100	70 to 130	±30	90
Manganese (total and dissolved)	EPA 6010B or CLP SOW	Standard Method RL	2	70 to 130	±30	90
TDS	SM2540C	Standard Method RL	20000	70 to 130	±30	90
Groundwater SVOC^b						
Pentachlorophenol	EPA 3535A + 8270D MS-MS or CLP SOW	0.1	0.1	50-150	±30	90
2-methylnaphthalene	EPA 3535A + 8270D MS-MS or CLP SOW	Standard Method RL	0.02	CLP	CLP	90
Acenaphthene	EPA 3535A + 8270D MS-MS or CLP SOW	1.5	0.02	50-150	±30	90
Acenaphthylene	EPA 3535A + 8270D MS-MS or CLP SOW	Standard Method RL	0.02	50-150	±30	90
Anthracene	EPA 3535A + 8270D MS-MS or CLP SOW	4.5	0.02	50-150	±30	90
Benzo(a)anthracene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.01	0.02	50-150	±30	90
Benzo(a)pyrene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.01	0.02	50-150	±30	90
Benzo(b)fluoranthene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.01	0.02	50-150	±30	90
Benzo(g,h,i)perylene	EPA 3535A + 8270D MS-MS or CLP SOW	Standard Method RL	0.02	50-150	±30	90
Benzo(k)fluoranthene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.01	0.02	50-150	±30	90
Chrysene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.01	0.02	50-150	±30	90
Dibenzo(a,h)anthracene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.0035	0.02	50-150	±30	90

TABLE 2-2
Measurement Performance Criteria

Matrix/Parameter	Method	Project Target Reporting Limit per Table 2-1 (µg/L unless unit shown)	Laboratory Target Standard Reporting Limit (µg/L unless unit shown)	Accuracy (percent recovery)	Precision (relative percent deviation)	Completeness (percent)
Fluoranthene	EPA 3535A + 8270D MS-MS or CLP SOW	1.5	0.02	50-150	±30	90
Fluorene	EPA 3535A + 8270D MS-MS or CLP SOW	1.5	0.02	50-150	±30	90
Indeno(1,2,3-cd)pyrene ^c	EPA 3535A + 8270D MS-MS or CLP SOW	0.01	0.02	50-150	±30	90
Naphthalene	EPA 3535A + 8270D MS-MS or CLP SOW	41	0.02	50-150	±30	90
Phenanthrene	EPA 3535A + 8270D MS-MS or CLP SOW	Standard Method RL	0.02	50-150	±30	90
Pyrene	EPA 3535A + 8270D MS-MS or CLP SOW	7.5	0.02	50-150	±30	90
Groundwater/Field Parameters						
Salinity	Field – Multiparameter probe	0.01 percent	NA	NA	NA	90
pH	Field – Multiparameter probe	0.1 S.U.	NA	NA	NA	90
Conductivity	Field – Multiparameter probe	0.1 mS/cm	NA	NA	NA	90
Dissolved oxygen	Field – Multiparameter probe	1 mg/L	NA	NA	NA	90
Redox Potential	Field – Multiparameter probe	1 mV	NA	NA	NA	90
Temperature	Field – Multiparameter probe	0.1 °C	NA	NA	NA	90
Depth to water	Water Level Indicator	0.01 foot	NA	NA	NA	90
Depth to NAPL (if present)	NAPL interface probe	0.01 percent	NA	NA	NA	90

Notes:

For CLP analysis, lower-level statement of work limits (SIM for organics) are shown. As needed, if the final reporting limits are higher than the project criteria, then project team will use laboratory-specific MDLs, which are significantly lower than the reporting limits. For analytes not covered by CLP, EPA Regional Laboratory criteria apply.

^a Method 353.2 reports a combined nitrate+nitrite result.

^b Groundwater samples collected from monitoring wells with NAPL present will be identified on the chain-of-custody form. Upon receipt/login of the samples by the laboratory, the samples will be visually inspected for LNAPL and DNAPL as much as possible through amber glass. If present, a NAPL reduction procedure will be developed and implemented and the reduction step documented in the project file.

^c Indicates MEL standard MRL does not meet project criterion. MEL will attempt to achieve the 0.01ug/L MRL to meet project target reporting limits of all but dibenzo(a,h)anthracene.

°C	degrees Celsius	mg/L	milligrams per Liter	NAPL	nonaqueous-phase liquid
ug/L	micrograms per Liter	mS/cm	millisiemens per centimeter	RL	reporting limit
CLP	Contract Laboratory Program	mV	millivolt	S.U.	standard unit
MDL	method detection limit	NA	not applicable	SVOC	semivolatile organic compound
				TDS	total dissolved solids

SECTION 3

Data Generation and Acquisition (EPA Group B)

This section describes the sampling design; sampling methods; sampling handling and custody; analytical methods; QC; instrument and equipment testing, inspection and maintenance; instrument and equipment calibration and frequency, inspection and acceptance of supplies and consumables; nondirect measurements; and data management.

3.1 Sampling Design (Experimental Design) (B1)

The rationale for the design is described in step seven of the DQO process shown in [Appendix A](#), Data Quality Objectives.

3.2 Sampling Methods (B2)

Methods and protocols are described in [Appendix B](#), Field Procedures. Procedures follow EPA CLP guidance (EPA, 2014b; *CLP Samplers Guide* for requirements relating to containers, preservatives, and shipping²).

3.3 Sample Handling and Custody (B3)

A sample is physical evidence collected from a potential hazardous waste site, the immediate environment, or another source. Because of the potential evidentiary nature of samples, the possession of samples must be traceable from the time the samples are collected until they are introduced as evidence. In addition to field notebooks, a number of documents are available for tracking sample custody.

Field documents including sample custody seals and COC records will be obtained from the RSCC in EPA's R10 Quality Assurance Office. COC procedures will be used to maintain and document sample collection and possession. After sample packaging, the appropriate COC form will be completed. Scribe software will be used for project data management and completing COC documentation.

The Scribe COC and related exported project files are submitted to the CLP and the RSCC in accordance with the R10 DMP requirements. This includes providing the RSCC with the COC .xml file and Scribe custom data view .xls file on the day of each shipment, as well as uploading the COC .xml file to the Sample Management Office (SMO) Portal. The lab copy is sent to CLP and subcontracted labs, while the regional copy is sent to MEL. All Scribe project information, sample information, and documentation (labels and COCs) must be completed according to the R10 RSCC sampling guidelines. A separate unique COC will be created for each cooler shipped or delivered, documenting the specific contents and location of the associated cooler.

The following subsections summarize each element of sample handling and custody. The sample management and documentation procedures are described in the program-specific field procedures ([Appendix B](#)).

3.3.1 Chain-of-Custody

Because samples collected during any investigation could be used as evidence, their possession must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. COC procedures are followed to document sample possession.

3.3.1.1 Definition of Custody

A sample is under custody if one or more of the following criteria are met:

- The sample is in a person's physical possession.
- The sample is in a person's view after being in his or her physical possession.
- The sample was in a person's physical possession and was then locked up or sealed to prevent tampering.

² http://www.epa.gov/sites/production/files/2015-03/documents/samplers_guide.pdf

- The sample is kept in a designated secured area.

3.3.1.2 Field Custody

Only enough material to provide a good representation of the media being sampled will be collected. To the extent possible, the quantity and types of samples and sample locations are determined before the actual fieldwork is performed. As few people as possible should handle samples. The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly. The PM determines whether proper custody procedures were followed during the fieldwork, and decides whether additional samples are required.

3.3.1.3 Transfer of Custody and Shipment

Samples are accompanied by a COC record. When transferring samples, the individuals relinquishing and receiving the samples sign, date, and note the time on the record. This record documents custody transfer from the sampler, often through another person, to the analyst at the laboratory.

Samples are packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate COC record accompanying each shipping container (one for each field laboratory if being used and one for samples driven to the laboratory). Shipping containers will be sealed with custody seals for shipment to the laboratory. Courier names and other pertinent information are entered in the “Received by” section of the COC record. The RSCC will be notified of shipment and the Scribe .xml file will be uploaded to the CLP SMO Portal Web site on the day of shipment.

All shipments are accompanied by the COC record identifying its contents. The original record and one copy accompany the shipment to the laboratory, and a second copy is retained by the PM. The Scribe .xml file is also emailed to the RSCC along with the R10 template custom view .xls file export.

A separate unique TR-COC and Airbill will be created for each cooler shipped, documenting the specific contents and location of the associated cooler. Freight bills, postal service receipts, and bills of lading are retained as part of the permanent documentation.

3.3.1.4 Laboratory Custody Procedures

A designated sample custodian accepts custody of the shipped samples and verifies that the sample numbers match those on the COC records. Pertinent information about shipment, pickup, and courier is entered in the “Remarks” section. The custodian then enters the sample numbers into a bound notebook. The laboratory custodian uses the sample identification number or assigns a unique laboratory number to each sample, and is responsible for ensuring that all samples are transferred to the proper analyst or stored in the appropriate secure area.

The custodian distributes samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian. The data from sample analyses are recorded on the laboratory report form.

When sample analyses and necessary QC checks have been completed in the laboratory, the unused portion of the sample will be disposed of properly. All identifying sample tie tags, data sheets, and laboratory records are retained as part of the documentation. Sample containers and remaining samples are disposed of by the laboratory in compliance with all federal, state, and local regulatory requirements.

3.3.2 Custody Seals

Custody seals will be placed on coolers during transport of samples to the laboratory. The seals will be placed on two sides of the lid (one in front, and one on the side) and covered with tape to prevent inadvertent breaking of the seals. To prevent the opening of coolers during shipment and to ensure that the samples remain sealed under custody until arrival at the lab additional large liner bag (drum liner type) inside around entire contents of cooler (ice and samples), tied tightly closed and secured with additional custody seal will also be used.

3.3.3 Field Notebooks

A bound field notebook will be maintained by each sampling FTL to provide a daily record of significant events, observations, and measurements during field investigations. All entries will be signed and dated. The notebook will be retained by each agency as a permanent record, and copies of field notes from each sampling event will be submitted to EPA. These notebooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project, and to refresh the memory of the field personnel, if required. Field data collected in field notebooks will be entered electronically for upload and final storage.

3.3.4 Corrections to Documentation

All original data recorded in field notebooks and field data forms will be written in waterproof ink, unless prohibited by weather conditions. None of these accountable serialized documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document, then the FTL may make corrections simply by drawing a single line through the error and entering the correct information. The erroneous information should not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

3.4 Analytical Methods (B4)

Project analytes, methods and target laboratory detection limits are listed in [Table 2-2](#). Samples for semivolatile organic analyses will be analyzed through the EPA MEL or the CLP and the associated statements of work/SOP along with CLP QA/QC requirements. Other analyses listed on [Table 2-2](#) will be analyzed through MEL per referenced standard EPA methods and MEL SOPs and QA/QC. As directed by EPA QAO these analyses may also be subcontracted. No analytical testing is needed for IDW management because liquid IDW generated during field sampling and decontamination tasks will be processed at the onsite treatment plant. All analyses will be subject to minimum QC requirements specified in Section 3.5.

Samples will be visually assessed for presence of NAPL upon laboratory receipt as much as possible through amber glass containers. Samples collected from monitoring wells with NAPL (LNAPL or DNAPL) will be identified on the chain-of-custody form. Upon receipt/login of the samples by the laboratory, the samples will be visually inspected for LNAPL and DNAPL. If present, a NAPL reduction procedure will be developed and implemented and the reduction documented in the project file.

3.5 Quality Control (B5)

3.5.1 Field Quality Control Procedures

QC requirements related to the sample collection process (i.e., sample design, sampling procedures, and field QC samples) are described in [Appendix B](#). The QC samples will be collected immediately following collection of normal samples and using the same procedures as the collection of the normal sample. The field QC samples are described in the Field Procedures ([Appendix B](#)).

3.5.2 Laboratory Quality Control Procedures

Laboratory QC procedures will include the following:

- Analytical methodology and QC according to the methods listed in [Table 2-2](#) and lab SOP/SOW requirements
- Instrument calibration and standards as defined in the methods listed in [Table 2-2](#) and lab SOP/SOW requirements
- Laboratory blank measurements at a minimum of 5 percent or 1-per-batch frequency
- Accuracy and precision measurements at a minimum of 1 in 20 or 1 per batch frequency
- Data reduction and reporting according to the methods listed in [Table 2-2](#)

- Laboratory documentation equivalent to the CLP statement of work or MEL SOP

3.6 Instrument and Equipment Testing, Inspection, and Maintenance (B6)

Field instrument testing, inspection and maintenance will be recorded in field notebooks. Preventative maintenance is performed according to the procedures described in the manufacturer's instrument manuals, if applicable, including lubrication, cleaning, and the frequency of such maintenance. Instrument downtime is minimized by keeping adequate supplies of all expendable items, where expendable means an expected lifetime of less than 1 year. These items include batteries, oil, and cables. Preventative maintenance for field equipment (e.g., water level meter, pressure transducers, and the water quality meter) will be conducted in accordance with procedures and schedules outlined in the particular model's operation and maintenance handbook.

3.7 Instrument and Equipment Calibration and Frequency (B7)

3.7.1 Field Calibration Procedures

Planned instruments used in the field include salinity, pH, specific conductivity, dissolved oxygen, redox potential, and temperature probes/meters, water level indicators, and water/NAPL interface probes. Each of these instruments are manually calibrated at the beginning and end of each field sampling day according to the manufacturer's instructions. Additional calibration checks may be carried out by the field team if needed. Instrument adjustments will be in accordance with procedures and schedules outlined in the particular instrument's operations and maintenance manual. Calibration results will be recorded in the field notebook.

Scheduled periodic calibration, if any, of testing equipment does not relieve field personnel of the responsibility of employing properly functioning equipment. If an individual suspects an equipment malfunction, the device must be removed from service and tagged so that it is not inadvertently used, and appropriate personnel notified so that a recalibration can be performed or a substitute piece of equipment can be obtained. Equipment that fails calibration or becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment will be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

Results of activities performed using equipment that has failed recalibration will be evaluated. If the activity results are adversely affected, the results of the evaluation will be documented, and the PM and data users will be notified.

3.7.2 Laboratory Calibration Procedures

Laboratory calibration procedures are specified in the methods referenced in [Table 2-2](#) and in the laboratory's SOP.

3.8 Inspection and Acceptance of Supplies and Consumables (B8)

Supplies and consumables will be acquired and inspected in accordance with acquisition specifications upon receipt.

3.9 Nondirect Measurements (B9)

As described in Step 3 of the DQO process ([Appendix A](#)), data collected during this study will be compared with historical data. The types and sources of historical data to be used for comparison purposes are listed in [Table 3-1](#). These historical data may be used in conjunction with the data gathered during this study to characterize Lower Aquifer groundwater quality given the limitations shown in [Table 3-1](#).

TABLE 3-1

Secondary Data

Secondary Data	Data Source(s)	Date of Collection	How Data Will Be Used	Data Quality Issues	Limitations on Use
Historical chemistry data	Published reports by USACE and CH2M	1994-2014	Comparison	None identified	None
USACE United States Army Corps of Engineers					

3.10 Data Management (B10)

Data obtained will undergo three levels of review and validation: (1) in the field, (2) laboratory data review and verification, and (3) outside the laboratory by third-party independent data verification and validation. Data management is discussed further in Section 5 (EPA Group D) of this QAPP. Following receipt of reviewed and validated data, the data will be uploaded to Scribe and published to scribe.net to facilitate data access, queries, and report preparation. Data management practices are detailed in the *Project Data Management Plan* (CH2M, 2011). Scribe software will be used to document and manage sample custody, location information, and field data measurements in accordance with the R10 DMP (2014).

SECTION 4

Assessment and Oversight (EPA Group C)

This section describes assessment, oversight, and reports to management.

4.1 Assessments and Oversight (C1)

The QAO, senior reviewers, and PM will monitor the performance of the QA procedures. If problems arise or the EPA TOPO directs the PM accordingly, then the QAO will conduct field audits. Field audits may be scheduled to evaluate the following:

- Execution of sample identification, COC procedures, field notebooks, sampling procedures, and field measurements
- Whether trained personnel staffed the sample event
- Whether equipment was in proper working order
- Availability of proper sampling equipment
- Whether appropriate sample containers, sample preservatives, and techniques were used
- Whether sample packaging and shipment were appropriate
- Whether QC samples were properly collected

Sample analyses will be carried out at EPA MEL or an EPA CLP laboratory. Analyses, if needed, may also be carried out at subcontract labs as directed by RSCC. The distribution of analyses to the laboratories will be determined according to laboratory capability and capacity and the sampling schedule. The distribution of analyses may change at the time of analysis depending on capacity and implementation of specific procedures at the Regional Laboratory. The RSCC, residing at EPA's Environmental Services Unit, will be responsible for coordinating and scheduling analytical services from the CLPs and MEL. The data quality and laboratory performance of CLP laboratories are monitored by the Analytical Services Branch in EPA Headquarters and the region's Quality Staff, including the CLP COR and RSCC. For MEL, QA oversight is provided by the laboratory's QA Coordinator. In addition, onsite audits or performance evaluation samples will be administered by the CH2M QAO and EPA Regional QAO, as necessary. Audits will be followed up with an audit report prepared by the reviewer. The auditor will also debrief the laboratory or the field team at the end of the audit and request that the laboratory or field team comply with the corrective action request.

If QC audits result in detection of unacceptable conditions or data, the PM will be responsible for developing and initiating corrective action. The TOPO will be notified if non-conformance is of program significance or requires special expertise not normally available to the project team. In such cases, the PM will decide whether any corrective action should be pursued. Corrective action could include the following:

- Reanalyzing samples if holding time criteria permit
- Resampling and analyzing
- Evaluating and amending sampling and analytical procedures
- Accepting data acknowledging a level of uncertainty

All corrective actions will be documented in a field logbook.

4.2 Reports to Management (C2)

The PM or TOPO may request that a QA report be made to the TOPO on the performance of sample collection and data quality. The report will include the following:

- Assessment of measurement data accuracy, precision, and completeness
- Results of performance audits
- Results of systems audits
- Significant QA problems and recommended solutions

Progress reports, prepared as needed, will summarize overall project activities and any problems encountered. QA reports generated on sample collection and data quality will focus on specific problems encountered and solutions implemented. Alternatively, in lieu of a separate QA report, sampling and field measurement data quality information may be summarized and included in the final reports. The objectives, activities performed, overall results, sampling, and field measurement data quality information for the project will be summarized and included in the final reports along with any QA reports.

A field sampling report listing the samples collected, sample locations, field duplicates, and dates of sample collection and shipment will also be generated to support the data validation activities. Field data will be presented in a final report to EPA as a separate deliverable because the data will be used qualitatively.

SECTION 5

Data Validation and Usability (EPA Group D)

This section introduces the concepts of data review, verification, and validation; describes verification and validation methods; and explains reconciliation with user requirements.

5.1 Data Review, Verification, and Validation (D1)

Data for all parameters (except MEL data) will undergo two levels of review and validation: (1) at the laboratory data review and verification, and (2) outside the laboratory by third-party independent data verification and validation. CLP-generated data will be verified and validated by the Quality Staff in EPA's Environmental Services Unit prior to authorization of payment to the laboratory. The data generated by the regional EPA laboratory (MEL) are reviewed and verified internally at MEL and is not considered 'validation' although validation qualifiers are applied as needed. If needed, the EPA R10 QA unit may validate MEL data for unique circumstances where it is requested, such as for litigation support. All validated CLP laboratory data are downloaded directly by CH2M in the SMO Portal and as needed emailed by EPA QA to CH2M. The stage of validation assigned to each Sample Delivery Group (SDG) will determine when the data are final and appropriate for download and project use (see Section 5.2). The data generated by the subcontracted commercial laboratories will be validated by CH2M or an independent third-party data reviewer. Stage of data validation as explained below will be included in the data validation report.

5.2 Verification and Validation Methods (D2)

Initial data reduction, validation, and reporting at the laboratory will be performed as described in the laboratory-specific SOPs. Independent data validation by EPA or their designee and subcontracted laboratory data validation by CH2M will follow EPA *Contract Laboratory Program National Functional Guidelines for Inorganic/Organic Data Review* (EPA, 2014c), as described above. CH2M validation of subcontracted data for methods other than CLP or CLP equivalent (e.g., Method 6010) will follow EPA guidance as applicable to method QC parameters (e.g., American Standard for Testing and Materials methods). An equivalent level of effort as prescribed in the guidance will be implemented. The minimum level of effort for subcontracted data validation will be at 70% Stage 2B electronic validation (S2BVE) and 30% Stage 4 electronic and manual data validation (S4VEM).

EPA validation of CLP data is labeled with a level-of-effort "Stage" identification in accordance with *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009). Standardized terminology for identification of data validation is designed to help increase national consistency and improve communication and understanding about the nature of verification and validation conducted on laboratory analytical data for Superfund use. An in-depth definition of each data validation stage label can be found in [Appendix A](#) of the cited EPA guidance document.

Inorganic and organic CLP data is electronically validated at S3VE through validation software prior to delivery at the SMO Portal. For this project, a full S4VEM (100 percent S4VEM) will be performed. All EDDs will be downloaded by the project staff/designated contractors from the CLP SMO Portal. EPA QA chemists will notify the project data managers with SMO Portal access when SDGs are designated for validation (30 percent). Those designated SDGs are not final until the EPA QA Data Validation Report has been sent out and the data reflect the "S4VEM" DV label. Validation report memorandums and qualified results will be prepared by the validator (EPA S4VEM) and submitted to the EPA PM and the contractor's PMs.

The data generated by the regional EPA laboratory (MEL) is reviewed and verified internally at MEL and validation qualifiers are applied as needed; MEL data review is considered equivalent to a Stage 4 (S4VM). If needed, the EPA R10 QA unit may validate MEL data for unique circumstances where it is requested. The stage of data validation as explained below will be included in the data validation report. All data is reported in the R10 EDD format, also known as the EPA national Universal EDD, as defined in the 2014 DMP.

5.3 Reconciliation with User Requirements (D3)

Analytical data obtained will be reconciled with the requirements specified in [Table 2-2](#). Assessment of data for precision, accuracy, and completeness will be performed in accordance with the quantitative definitions in the following subsections.

5.3.1 Precision

If calculated from duplicate measurements, use the following equation:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2) / 2} \quad (1)$$

Where:

RPD	=	relative percent difference
C ₁	=	larger of the two observed values
C ₂	=	smaller of the two observed values

If calculated from three or more replicates, use relative standard deviation rather than the relative percent difference, as follows:

$$RSD = (s / \bar{y}) \times 100\% \quad (2)$$

Where:

RSD	=	relative standard deviation
s	=	standard deviation
\bar{y}	=	mean of replicate analyses

Standard deviation, s, is defined as follows:

$$S = \sqrt{\sum_{i=1}^n \frac{(y_i / \bar{y})^2}{n-1}} \quad (3)$$

Where:

s	=	standard deviation
y _i	=	measured value of the i th replicate
\bar{y}	=	mean of replicate analyses
n	=	number of replicates

5.3.2 Accuracy

For measurements where MSs are used, use the following:

$$\%R = 100\% \times \left[\frac{S - U}{C_{sa}} \right] \quad (4)$$

Where:

%R	=	percent recovery
S	=	measured concentration in spiked aliquot
U	=	measured concentration in unspiked aliquot
C _{sa}	=	actual concentration of spike added

For situations where a standard reference material is used instead of or in addition to MSs, use the following:

$$\%R = 100\% \times \left[\frac{C_m}{C_{sm}} \right] \quad (5)$$

Where:

%R	=	percent recovery
C _m	=	measured concentration of standard reference material
C _{sm}	=	actual concentration of standard reference material

5.3.3 Completeness (Statistical)

Defined as follows for all measurements:

$$\%C = 100\% \times \left[\frac{V}{T} \right] \quad (6)$$

Where:

%C	=	percent completeness
V	=	number of measurements judged valid
T	=	total number of measurements

SECTION 6

References

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Appendix A
Systematic Planning Summary and
Data Quality Objectives

Systematic Planning and Data Quality Objectives

This appendix presents the systematic planning process for the sampling and analysis activities to assess Lower Aquifer groundwater quality trends at the Wyckoff/Eagle Harbor Superfund Site on Bainbridge Island, Washington. The information presented in this appendix is based on a data quality objectives (DQOs) scoping meeting conducted on February 9, 2016 with U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology, and CH2M representatives. The data collected as a result of this scoping meeting will be used to support preparation of a Lower Aquifer Quality Assurance Project Plan (QAPP) with the primary objective of collecting the data needed to determine if current and future Upper Aquifer remedial actions are preventing further degradation of the Lower Aquifer within Operable Unit (OU) 4 and to support selection of a final Lower Aquifer remedy in a future Comprehensive Environmental Response Compensation and Liability Act (CERCLA) decision document.

A.1 Step 1—Background and Problem Statement

A.1.1 Background Information

The Wyckoff/Eagle Harbor Superfund Site encompasses the contaminated areas of Eagle Harbor and adjoining uplands of the former Wyckoff wood-treating facility. The Superfund Site is divided into four OUs:

- **East Harbor OU1**—subtidal and intertidal sediments in Eagle Harbor adjacent to Wyckoff Point.
- **Soil OU2**—surface and unsaturated subsurface soil in the former Wyckoff wood treating process and storage area.
- **West Harbor OU3**—sediments and uplands of former shipyard.
- **Groundwater OU4**—groundwater and soil in the saturated zone beneath the Soil OU.

The Soil and Groundwater OUs comprise the approximately 19-acre area affected by releases of wood treating chemicals during the 85-year operating history of the Wyckoff facility. The Former Process Area (FPA) is an approximate 8-acre portion of the Soil and Groundwater OUs where wood treatment operations were primarily conducted and where large volumes of subsurface nonaqueous phase liquid (NAPL), including dense NAPL (DNAPL) and light NAPL (LNAPL) have been observed in wells and borings.

Remedial action objectives (RAO) for the Lower Aquifer are defined in the *EPA Record of Decision: Wyckoff/Eagle Harbor EPA ID: WAD00928295 OU 02, 04 Bainbridge Island, WA* (EPA, 2000) and in the *Proposed Plan for the Wyckoff Eagle Harbor Superfund Site – OUs 2 and 4* (EPA, 2016) as follows:

A.1.1.1 Lower Aquifer Related RAOs Specified in the 2000 Record of Decision (ROD)

- Protect humans from exposure to groundwater containing contaminant concentrations above MCLs [maximum contaminant levels].
- Protect the groundwater outside the FPA and in the Lower Aquifers, which are potential drinking water sources.

A.1.1.2 Lower Aquifer RAO Presented in the Proposed Plan

- Upland RAO 4—Prevent further degradation of the Lower Aquifer. Prevent use of Lower Aquifer groundwater that would result in unacceptable risk to human health until restoration goals are met.

The current OU2/OU4 remedy, implemented under the 2000 ROD is designed to physically contain contaminated Upper Aquifer groundwater and NAPL within the FPA using a perimeter sheet pile wall and to protect the Lower Aquifer by pumping groundwater from the Upper Aquifer to maintain an upward vertical hydraulic gradient.

Groundwater monitoring to demonstrate hydraulic containment and monitor changes in contaminant concentrations was initiated in 2004. Hydraulic containment monitoring involves continuous water-level monitoring using data loggers installed in upper and Lower Aquifer monitor well pairs and comparing average groundwater elevations at each well pair. Hydraulic containment monitoring results are presented in periodic (quarterly or semiannual) reports. Locations for all FPA wells are shown on [Figure A-1](#), and construction information for the Lower Aquifer wells provided in [Table A-2](#).

Lower Aquifer groundwater quality monitoring is conducted on an annual basis at a subset of the 24 monitoring wells and piezometers screened in the Lower Aquifer. Under the previous sampling program, the rationale for selecting specific wells for sampling varied depending on the objectives of each event. In general the well location and well construction information, in conjunction with measurements and observations from previous sampling events, were used to select monitoring wells to meet event specific objectives. The Groundwater Sampling Event Planning form documents how selected wells will meet the objectives. The groundwater samples were typically analyzed for semivolatile organic compounds, polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), and total petroleum hydrocarbons (TPH)-diesel, and TPH-motor oil, and the laboratory analysis results presented in annual reports.

A.1.2 Conceptual Site Model

The Lower Aquifer consists primarily of sand, with small amounts of silt, clay, and gravel. The upper boundary of the Lower Aquifer is relatively shallow, daylighting just south of the FPA and sloping down to depths of approximately 90 feet at the north end of the FPA. The lower boundary has not been defined within the FPA. However, it is believed that the Lower Aquifer extends to depths up to approximately 200 or 250 feet below ground surface (bgs). The portion of the Lower Aquifer to be assessed under this QAPP is the region bounded by the current Lower Aquifer monitoring well network.

Groundwater in the Lower Aquifer (approximately 80 to 200 feet bgs) is characterized as potable (Class II) and nonpotable (Class III). The boundary between potable and nonpotable groundwater, which is defined by a total dissolved solids (TDS) concentration of 10,000 milligrams per liter (mg/L) or specific conductance of approximately 17 milliseimens per centimeter (mS/cm), extends across the FPA ([Figure A-1](#)). Lower Aquifer groundwater within the 80 to 200 foot depth interval is not currently used, however, there is a water supply well located just outside the southwest corner of the FPA that is screened at much deeper elevation that has been identified by the City of Bainbridge Island as a backup water supply well. EPA is still evaluating the City's request to use this well as a backup water source.

Groundwater flow in the Upper and Lower Aquifer prior to installation of the sheet pile wall (original conditions) was from south to north, toward Eagle Harbor and Puget Sound. The flow was also upward from the Lower Aquifer to the Upper Aquifer as expected in a sea level groundwater discharge zone. Groundwater in the Upper Aquifer flowed from the southern portion of the Wyckoff Site north toward Eagle Harbor and Puget Sound, where it formerly discharged into the intertidal and subtidal zones. The perimeter sheet pile wall now impedes Upper Aquifer groundwater flow while the pump-and-treat system extracts Upper Aquifer groundwater to maintain a net upward vertical hydraulic gradient from

the Lower Aquifer to the Upper Aquifer and to maintain an inward flow gradient within the Upper Aquifer. The sheet pile wall and pump-and-treat system to not effect Lower Aquifer groundwater flow patterns.

The last Lower Aquifer groundwater quality sampling event was conducted in October 2014 where 11 of the 24 monitoring wells were sampled. The criteria used for selection of the 11 Lower Aquifer wells included well locations relative to the Upper Aquifer treatment zones, NAPL presence and thickness above the aquitard, aquitard thickness, and PAH concentrations in Lower Aquifer groundwater. The number of wells sampled was reduced from previous events based on this evaluation.

For the October 2014 sampling event, of the 11 Lower Aquifer wells sampled, six (VG1L, VG4L, VG5L, P4L, CW09, and 99CDMW02) contained non-detectable or contaminant of concern (COC) concentrations below ROD specified cleanup levels (CULs). Laboratory analysis of samples collected at monitoring wells CW05, CW15, P3L, PZ11, and VG2L contained one or more COCs at concentrations above the CULs specified in the 2000 ROD.

Based on a review of current and historical analytical data for the upper and Lower Aquifer, two areas of the Lower Aquifer were identified with elevated PAH concentrations: one in the northern portion of the FPA in the vicinity of monitoring wells CW05, CW15, P3L, and VG2L, and one southwest of the FPA near well PZ11. These areas may indicate the presence of a preferred contaminant transport pathway between the upper and Lower Aquifer or the presence of NAPL in the aquitard in these areas. Acenaphthene has been consistently detected above its 3.0 µg/L CUL at wells CW15, P3L, and VG2L since sampling began as far back as 1994.

In June 2012, NAPL measurements were performed at selected Lower Aquifer monitoring wells to determine the absence/presence of NAPL. These measurements were performed again in October 2014. Based on these measurements NAPL or evidence of NAPL (e.g. sheen) was observed at five Lower Aquifer wells (VG-2L, P-3L, and CW15 in 2012 and 2014, and CW05 and 99CDMW02A in 2014) located in the northern portion of the FPA where elevated PAH concentrations in groundwater have been observed. NAPL measurements were not attempted at monitoring well PZ11 in 2012, and NAPL was not observed on the sounding tape used at PZ11 in October 2014. But based on PZ11 water quality results, the presence of NAPL in the vicinity of this well is possible.

Based on the October 2014 Lower Aquifer groundwater salinity levels, seven of the monitoring wells are influenced by saltwater intrusion. The location of the freshwater-saltwater interface in the Lower Aquifer shifts in response to daily tidal fluctuations. The location of this interface influences PAH concentrations in the groundwater samples. Excluding tidal influence effects, acenaphthene concentrations appear to be relatively stable except at wells P3L and CW05 located on the north side of the FPA and at VG2L located on the northeast side of the FPA. Based on laboratory testing of DNAPL samples collected from the Upper Aquifer in May 2014, the effective solubility of acenaphthene is estimated at 48 µg/L. Acenaphthene concentrations above this level at wells CW05, CW15, P3L, and VG2L may indicate the presence of DNAPL in the vicinity of the well.

A.1.3 Objectives and Problem Statements

The following problem statements/ objectives were developed for this QAPP:

- Need to determine NAPL presence, distribution and thickness in the Lower Aquifer
- Need to determine general water quality for use in establishing potential drinking water zones and evaluating spatial and temporal trends for Lower Aquifer groundwater.

- Need to develop a dissolved-phase contaminant concentrations and distribution baseline for use in confirming no further degradation of the Lower Aquifer by source control actions taken in the Upper Aquifer.
- Need to dispose of investigation-derived waste (IDW) properly.

A.1.4 Systematic Planning Team

A systematic planning process was used to develop the DQOs and sampling design for Lower Aquifer groundwater sampling and analysis. The members and affiliations of the planning team are listed below:

- Helen Bottcher /EPA Project Manager
- Chung Yee/ Washington State Department of Ecology Project Manager (Note: Hun Seek replaced Mr. Yee on May 1, 2016)
- Ken Scheffler/CH2MHILL Project Manager
- Mark Cichy/ CH2M HILL Quality Assurance Officer
- Scott McKinley/CH2M HILL Senior Hydrogeologist
- Valerie Panek/CH2M HILL Senior Hydrogeologist

A.2 Step 2—Identify the Decision/Principal Study Questions

The purpose of DQO Step 2 is to define the principal study questions (PSQs) to be resolved using new or existing measurements. Alternative actions are identified that could result from resolution of the PSQs, and the consequences of each of the alternative actions are evaluated in this step. The PSQs and possible outcomes for problem statements 1 through 4 from Step 1 are provided below:

A.2.1 NAPL Distribution

- Key Questions/Decisions:
 - What are the current/future distribution and thickness of NAPL in the Lower Aquifer within OU4
 - What is the current/future distribution of NAPL in the Lower Aquifer compared with the Upper Aquifer, and what are the possible migration pathways?
- Possible Outcomes:
 - Field measurement results will be used to: 1) refine the conceptual site model (CSM) regarding NAPL distribution and migration pathways; 2) support Upper Aquifer source control remedial action performance evaluations; 3) assess Upper Aquifer source control remedial action progress with respect to current and future RAOs; and 4) develop information to support selection of a final remedy for the Lower Aquifer in a future CERCLA decision document.
- Alternative Outcomes:
 - Expansion of areas with NAPL occurrence in potable/nonpotable groundwater and/or increasing COC concentrations in potable groundwater may trigger the need for a focused feasibility study (FFS) to support the evaluation and selection of a remedy in a future CERCLA decision document.

A.2.2 Water Quality

- Key Questions/Decisions:

- What are the concentrations of general water quality parameters in the Lower Aquifer that define potable and non-potable groundwater occurrences and zones of salt water intrusion and do these concentrations vary spatially and temporally?
- What are the concentrations of COCs in Lower Aquifer groundwater and do these concentrations vary spatially, temporally, and in response to tidal fluctuations?
- What is the correlation between laboratory-measured TDS and field-measured salinity?
- What is the correlation between tidal fluctuations, TDS, and COC concentrations?
- Possible Outcomes:
 - Sampling results will be used to determine spatial and temporal trends in groundwater quality for the Lower Aquifer.
 - The location of the Class II/III groundwater boundary, as defined by the 10,000 mg/L TDS isopleth, will be used to further define potable and non-potable groundwater zones within the Lower Aquifer.
 - Sample results will be used to determine the correlation between laboratory-measured TDS and field-measured salinity.
 - TDS and COC laboratory analysis results will be correlated to determine the effects of salt water intrusion on sample representativeness and COC concentrations.
- Alternative Outcomes:
 - None identified.

A.2.3 Source Control Effectiveness

- Key Questions/Decisions:
 - What are the baseline COC concentrations and general water quality conditions in Lower Aquifer groundwater prior to implementation of Upper Aquifer source control actions?
 - What are the COC concentrations and general water quality conditions in Lower Aquifer groundwater following implementation of Upper Aquifer source control actions?
- Possible Outcomes:
 - Sampling results will be used to support source control remedial action performance evaluation with respect to meeting the current RAO or protecting Lower Aquifer groundwater as a drinking source and the future RAO of no further degradation.
- Alternative Outcomes:
 - None identified.

A.2.4 IDW Disposal

- Key Questions/Decisions:
 - How should investigation-derived, water, personal protective equipment (PPE), and sampling equipment wastes be disposed of in accordance with regulations?
- Possible Outcomes:

- Purge water from groundwater sampling – Place in secondary containment pads and transferred to the onsite Wyckoff groundwater treatment plant (GWTP) for treatment in accordance with the QAPP *Groundwater Treatment Plant Operations and Maintenance* and addendum (CH2MHILL, 2013b, c).
- Equipment decontamination water – Place in secondary containment pads and transferred to the onsite Wyckoff GWTP for treatment in accordance with the QAPP *Groundwater Treatment Plant Operations and Maintenance* (CH2M, 2013a and 2013b).
- PPE and disposable sampling equipment – Disposal off-site as listed Hazardous Waste (relatively small volume).
- Alternative Outcomes:
 - None identified.

A.3 Step 3—Identify Inputs to the Decision

The purpose of DQO Step 3 is to identify the informational inputs that will be required to resolve PSQs and determine which inputs require environmental measurements, model computations, and/or sampling. Data needed to inform each of the key questions for the study are listed in the subsections that follow.

A.3.1 NAPL Distribution

- Needed information:
 - NAPL presence or absence ([Table A-1](#))
 - NAPL thickness
- Source of information:
 - NAPL measurements at the Lower Aquifer monitoring wells ([Table A-1](#))
- Action levels:
 - No action levels have been defined. NAPL thickness' of 0.05 feet are generally required for measurement methods to be effective and reproducible.
- Methods:
 - Appropriate field methods are shown in Table 2-2 of the QAPP.

A.3.2 Water Quality

- Needed information:
 - General chemistry (anions, cations, TDS) concentrations ([Table A-1](#))
 - COC concentrations ([Table A-1](#))
- Source of information:
 - Laboratory analysis of Lower Aquifer monitor well groundwater samples that provide spatial and temporal representativeness within OU4.
 - Wyckoff well construction information
- Action levels:

— Action levels are shown in [Table A-1](#)

- Methods:

— Appropriate field and laboratory methods are shown in [Table 2-2](#) of the QAPP.

A.3.3 Source Control Effectiveness

- Needed information:

— Groundwater COC and general water quality parameter concentrations from Lower Aquifer wells that are spatially and temporally representative ([Table A-1](#))

— Location of sampled well in relation to NAPL occurrences and source control technologies

- Source of information:

— Groundwater samples from different well locations within the Lower Aquifer monitoring well network to be analyzed offsite

— Wyckoff well construction information

- Action levels:

— Action levels are shown in [Table A-1](#)

- Methods:

— Appropriate laboratory methods are shown in [Table 2-2](#) of the QAPP.

A.3.4 IDW Disposal

- Needed information:

— IDW type (water, PPE, disposable equipment)

— Quantity

— Frequency of generation

— No laboratory or field analyses needed

- Source of information:

— Field identification

- Action levels:

— Not applicable – purge and decontamination water transferred to Wyckoff GWTP for treatment and disposal. PPE and disposable sampling equipment disposed under existing profile.

- Methods:

— No analytical testing is needed.

— Purge water from groundwater sampling – Place in secondary containment pads and transferred to the onsite Wyckoff GWTP for treatment in accordance with the *QAPP GWTP Operations and Maintenance* (CH2M, 2013a).

— Equipment decontamination water – Place in secondary containment pads and transfer to the onsite Wyckoff GWTP for treatment in accordance with the *QAPP Groundwater Treatment Plant Operations and Maintenance* and Addendum (CH2M, 2013a and 2013b).

- PPE and disposable equipment – Place in drums for later shipment offsite. Assumed to be Hazardous Waste based on previous process knowledge.

A.4 Step 4—Define the Boundaries of the Study

The primary objective of DQO Step 4 is for the DQO Team to identify the spatial, temporal, and practical constraints on the sampling design and consider the consequences. This objective (in terms of the spatial, temporal, and practical constraints) is to ensure that the sampling design results in the collection of data that accurately reflect the true condition of the site and/or populations being studied.

A.4.1 NAPL Distribution

- Population of interest:
 - NAPL
- Spatial Boundaries:
 - The spatial boundaries include that portion of the Lower Aquifer lying within OU4 and bounded by the existing Lower Aquifer monitoring well network lying beneath defined areas of Upper Aquifer NAPL occurrence.
- Temporal Boundaries:
 - Annual. The decisions regarding the results will hold until the next investigation/round of NAPL sampling for the designated wells.
- Chemical Boundaries:
 - None
- Potential obstacles to obtaining information:
 - Health and safety constraints
 - Site access constraints
 - Field equipment malfunction

A.4.2 Water Quality

- Population of interest:
 - Lower Aquifer groundwater
- Spatial Boundaries:
 - The spatial boundaries include that portion of the Lower Aquifer lying within OU4 and bounded by the existing Lower Aquifer monitoring well network lying beneath defined areas of Upper Aquifer NAPL occurrence.
- Temporal Boundaries:
 - Daily and annual tidal cycle. The week of July 18, 2016 provides a window with low tides up to - 2.0 ft-MLLW and an outgoing tide window from 6:00 a.m. to 1:00 p.m., and extended daylight hours. Sample locations at the north end of the FPA will be collected at the start of low tide. The decisions regarding the results will hold until the next investigation/round of sampling for the designated wells.

- Annual climatic cycle. During the mid-July seasonal rainfall is low and effects of rainfall infiltration minimized.
- Potential obstacles to obtaining information:
 - Health and safety constraints
 - Site access constraints
 - Field equipment malfunction

A.4.3 Source Control Effectiveness

- Population of interest:
 - Lower Aquifer groundwater
- Spatial Boundaries:
 - The spatial boundaries include that portion of the Lower Aquifer lying within OU4 and bounded by the existing Lower Aquifer monitoring well network lying beneath defined areas of Upper Aquifer NAPL occurrence.
- Temporal Boundaries:
 - Daily and annual tidal cycle. The week of July 18, 2016 provides a window with low tides up to - 2.0 ft-MLLW and an outgoing tide window from 6:00 a.m. to 1:00 p.m., and extended daylight hours. Sample locations at the north end of the FPA will be collected at the start of low tide. The decisions regarding the results will hold until the next investigation/round of sampling for the designated wells.
 - Annual climatic cycle. During the mid-July seasonal rainfall is low and effects of rainfall infiltration minimized.
- Potential obstacles to obtaining information:
 - Health and safety constraints
 - Site access constraints
 - Field equipment malfunction

A.4.4 IDW Disposal

- Population of interest:
 - PPE
 - Disposable sample equipment (sample tubing)
 - Groundwater from well purging
- Spatial Boundaries:
 - Decisions regarding IDW apply to the following containers:
 - Purge water from sampling will be placed in secondary containment pads and managed and disposed within the existing treatment system of the Wyckoff upland compound
 - Decontamination water will be placed in secondary containment pads and managed and disposed within the existing treatment system of the Wyckoff upland compound
 - PPE in plastic bags, for later storage in labeled drums at the upland Wyckoff facility pending transport for off-site disposal as listed Hazardous Waste

- Disposable equipment in plastic bags, for later storage in labeled drums at the upland Wyckoff facility pending transport for off-site disposal as listed Hazardous Waste
- Temporal Boundaries:
 - Decisions regarding IDW management and disposal will hold indefinitely.
- Potential obstacles to obtaining information:
 - None

A.5 Step 5—Develop a Decision Rule

The purpose of DQO Step 5 is to define the parameter of interest (e.g., mean), specify the action level, and integrate outputs from the previous DQO steps into a single statement that describes a logical basis for choosing among alternative actions.

A.5.1 NAPL Distribution

- Statistical Parameter of Interest:
 - Individual data points
- Action Levels:
 - See Table A-1
- Analytical Process / Decision Rules:
 - Results will be compiled into tables. Compare NAPL measurement results between wells and at different time steps to identify spatial and temporal variations.
 - Results will be used to refine the CSM and to support source control remedial action alternative evaluation and final remedy selection. No alternative actions.

A.5.2 Water Quality

- Statistical Parameter of Interest:
 - Individual and grouped data points- concentrations
- Action Levels:
 - See Table A-1
- Analytical Process / Decision Rules:
 - Compile groundwater anion/cation results by well. Compute anion/cation ratio and charge balance error to identify potential data usability issues (for example, laboratory analysis or reporting errors or sample quality issues). The target error for the charge balance is 10 percent.
 - Compare results between wells to identify spatial variations. Results will be presented in tables and on GIS figures. Anion and cation results will be presented on Piper or Stiff diagrams.
 - Determine location of 10,000 mg/L TDS isopleth and present on GIS figure.
 - Results will be used to refine the CSM, specifically as it relates to saltwater intrusion and the potential effects of salt water intrusion on COC concentrations.
 - Alternative actions. Stable and/or declining COC concentrations may support selection of monitored natural attenuation as a final Lower Aquifer remedy whereas rising COC

concentrations may trigger the need for an FFS study to develop and evaluate a range of alternatives.

A.5.3 Source Control Effectiveness

- Statistical Parameter of Interest:
 - Individual and grouped data – concentrations
- Action Levels:
 - See Table A-1
- Analytical Process / Decision Rules:
 - Compile groundwater COC concentration results by well. Compare results between wells and intra-well to identify spatial and temporal variations. Results will be presented in tables and on GIS figures.
 - Results will be used to refine the CSM and to support source control remedial action performance evaluation.
 - Alternative actions. Stable and/or declining COC concentrations may support selection of monitored natural attenuation as a final Lower Aquifer remedy whereas rising COC concentrations may trigger the need for an FFS to develop and evaluate a range of alternatives.

A.5.4 IDW Disposal

- Statistical Parameter of Interest:
 - Individual observation for PPE, disposable sample equipment, purge water, and decontamination water
- Action Levels:
 - Not applicable, no analysis required
- Analytical Process / Decision Rules:
 - Purge water will be placed in secondary containment pads and managed and disposed within the Wyckoff upland compound in accordance with the QAPP (CH2M, 2013a). Disposal will be documented in the field records.
 - Decontamination water will be placed in secondary containment pads and managed and disposed with within the Wyckoff upland compound in accordance with the QAPP and Addendum (CH2M, 2013a). Disposal will be documented in the field records.
 - PPE will be disposed of off-site as listed Hazardous Waste. Disposal will be documented in accordance with standard Hazardous Waste procedures.
 - Disposable sample equipment will be disposed of off-site as listed Hazardous Waste. Disposal will be documented in accordance with standard Hazardous Waste procedures.

A.6 Step 6—Specify Tolerable Limits on Decision Errors

The purpose of DQO Step 6 is to develop tolerable error limits for statistical sampling design. The decisions to be made regarding NAPL and groundwater sampling will be made based on professional judgment using biased (Team selected) wells. Therefore the parameters of this step do not apply.

A.7 Step 7—Optimize the Design

The purpose of DQO Step 7 is to identify the most resource-effective design while maintaining the desired degree of precision and accuracy.

The elements of the sampling design for each aspect of the study are listed in the subsections below. The operational details for sample collection and documentation are provided in [Appendix B](#) (Field Procedures).

A.7.1 Design Rationale

To answer the PSQs, NAPL thickness measurements and groundwater sampling are planned. Preliminary field and laboratory analysis with intended data use are provided in [Table A-1](#).

A subset of Lower Aquifer monitoring wells have been selected for NAPL thickness measurements and groundwater sampling and analysis. The selection process focused on Lower Aquifer monitoring wells that provide spatial coverage across the FPA but with a focus on wells lying beneath the Upper Aquifer's North Deep DNAPL geography because this area is expected to represent the primary DNAPL migration pathway between the upper and Lower Aquifers based on visual evidence of NAPL and elevated PAH concentrations observed during the 2014 sampling event.

A.7.2 Sampling Design

The operational details for this sampling design are covered in [Appendix B](#) under field procedures.

A.7.2.1 NAPL Distribution

Field measurements of NAPL presence/absence and thickness will be collected from the locations listed in [Table A-2](#) and shown on [Figure A-1](#). Groundwater samples will be analyzed for the parameters listed in [Table A-1](#).

A.7.2.2 Water Quality

Samples of groundwater will be collected from the locations listed in [Table A-2](#) and shown on [Figure A-1](#). The samples will be analyzed for the parameters listed in [Table A-1](#). Matrix spike/matrix spike duplicate (MS/MSD) will be submitted at a rate of 5 percent for all samples submitted for chemical analysis. Field duplicates will be submitted at a rate of 10 percent for all samples submitted for chemical analysis.

A.7.2.3 Source Control Effectiveness

Groundwater samples will be collected from the locations listed in [Table A-2](#) and shown on [Figure A-1](#). The samples will be analyzed for the parameters listed in [Table A-1](#). MS/MSD will be submitted at a rate of 5 percent for all samples submitted for chemical analysis. Field duplicates will be submitted at a rate of 10 percent for all samples submitted for chemical analysis.

A.7.2.4 IDW Disposal

No samples will be collected to characterize IDW.

TABLE A-1
Data Needs And Uses

Matrix/ Parameters	Analyte	Data Use	Data User	ROD CUL (µg/L) ^a	MTCA B (µg/L) ^b	Lowest Project Action Level (µg/L unless unit shown)	Target Reporting Limits per Lowest Project Criteria ^c (µg/L unless unit shown)
NAPL	Thickness	Determine absence/presence, and distribution	Site investigators, hydrogeologists, and remedial technologists	Not specified	Site-specific determination	0.05 feet	0.05 feet
Water Quality (anions and cations)	Calcium	Characterize concentrations in Lower Aquifer, calculate anion- cation balance and charge balance error, and refine the CSM.	Site investigators, hydrogeologists, and remedial technologists	None	None	500	Standard MRLs
	Magnesium					500	
	Potassium					500	
	Sodium					500	
	Chloride					60	
	Sulfate					300	
	Alkalinity					5,000	
	Nitrate (as Nitrate+Nitrite-N)					50	
	Iron (total and dissolved)					100	
	Manganese (total and dissolved)					2	
Water Quality	Total Dissolved Solids (TDS)	Characterize concentrations in Lower Aquifer, determine potable/non-potable zones, correlate with field salinity measurements, and refine the CSM.	Site investigators, hydrogeologists, and remedial technologists	None	None	20,000	Standard MRLs
Water Quality (COCs)	2-methylnaphthalene	Characterize dissolved phase concentrations outside NAPL source zones, refine the CSM, and support alternatives evaluation.	Site investigators, hydrogeologists, and remedial technologists	None	None	NA	Standard MRLs
	Acenaphthene			3	960	3	1.5
	Acenaphthylene			None	None	NA	Standard MRLs
	Anthracene			9	4,800	9	4.5

TABLE A-1
Data Needs And Uses

Matrix/ Parameters	Analyte	Data Use	Data User	ROD CUL (µg/L) ^a	MTCA B (µg/L) ^b	Lowest Project Action Level (µg/L unless unit shown)	Target Reporting Limits per Lowest Project Criteria ^c (µg/L unless unit shown)
	Benzo(a)anthracene			0.0296	0.12	0.0296	0.01
	Benzo(a)pyrene			0.0296	0.012	0.0296	0.01
	Benzo(b)fluoranthene			0.0296	0.12	0.0296	0.01
	Benzo(g,h,i)perylene			None	None	NA	Standard MRLs
	Benzo(k)fluoranthene			0.0296	1.2	0.0296	0.01
	Chrysene			0.0296	12	0.0296	0.01
	Dibenz(a,h)anthracene			0.007	0.012	0.007	<0.0035
	Fluoranthene			3	640	3	1.5
	Fluorene			3	640	3	1.5
	Indeno(1,2,3-cd)pyrene			0.030	0.12	0.030	0.01
	Naphthalene			83	160	83	41
	Pentachlorophenol			4.9	0.219	0.219	0.1
	Phenanthrene			None	None	NA	Standard MRLs
	Pyrene			15	480	15	7.5
Water Quality/ Field Parameters	Salinity	Characterize dissolved phase concentrations outside NAPL source zones, refine the CSM, and support alternatives evaluation.	Site investigators, hydrogeologists, and remedial technologists	NA	NA	0.01 percent	0.01 percent
	Dissolved oxygen					0.1 mg/L	0.1 mg/L
	pH			NA	NA	0.1 S.U.	0.1 S.U.
	Conductivity			NA	NA	1 mS/cm	1 mS/cm
	Redox Potential			NA	NA	1 mV	1 mV
	Temperature			NA	NA	0.1 °C	0.1 °C
	Depth to water			NA	NA	0.01 ft	0.01 ft

TABLE A-1
Data Needs And Uses

Matrix/ Parameters	Analyte	Data Use	Data User	ROD CUL (µg/L) ^a	MTCA B (µg/L) ^b	Lowest Project Action Level (µg/L unless unit shown)	Target Reporting Limits per Lowest Project Criteria ^c (µg/L unless unit shown)
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Notes:

^a CUL specified in Table 13 in the 2000 ROD (EPA, 2000).

^b Groundwater MTCA B Standard Formula value from the CLARC database (September 2015).

^c Approximately one-half of the lowest project action level

°C	degrees Celsius	CSM	conceptual site model	mS/cm	millisiemens per centimeter	NAPL	nonaqueous-phase liquid
µg/L	micrograms per liter	CUL	clean-up level	MTCA	Model Toxics Control Act	ROD	Record of Decision
CLARC	Cleanup Levels and Risk Calculation	mg/L	milligrams per liter	mV	millivolt	S.U.	standard unit
COC	contaminant of concern	MRL	method reporting limit	NA	not applicable	TDS	total dissolved solids

TABLE A-2

Lower Aquifer Groundwater Monitoring Sample Locations and Descriptions

Well Identified for Monitoring	Well Screen interval (feet bgs)	NAPL Thickness Measurements	Water Quality Sampling	NAPL Present
CW02	67 to 77		X	None Expected
CW05	89 to 99	X	X	Yes
CW09	95 to 105	X	X	None Expected
CW15	85 to 95	X	X	Yes
P-1L	85 to 95		X	None Expected
P-2L	103 to 113	X	X	None Expected
P-3L	110 to 120	X	X	Yes
P-4L	79 to 89	X	X	None Expected
P-5L	68 to 78	X	X	None Expected
P-6L	75 to 85		X	None Expected
PZ-11	15 to 25		X	None Expected
VG-1L	89 to 99		X	None Expected
VG-2L	115 to 125	X	X	Yes
VG-3L	85 to 95	X	X	None Expected
VG-4L	75 to 85		X	None Expected
VG-5L	61 to 71		X	None Expected
99CD-MW02A	73 to 83	X	X	Yes

Notes:

Sample locations are shown on Figure A-1

Presence of DNAPL determined during 2012 or 2014 monitoring event

bgs below ground surface

NAPL nonaqueous-phase liquid



LEGEND

- Lower Aquifer Well
- Fence
- Sheetpile Wall
- Roads
- Buildings
- Concrete Slab
- Structures
- * Vertical Gradient Monitoring Location
- Wells Identified for Annual Sampling Beginning in 2016
- Wells Identified for Annual Sampling Beginning in 2016 where DNAPL was Observed in 2012/2014

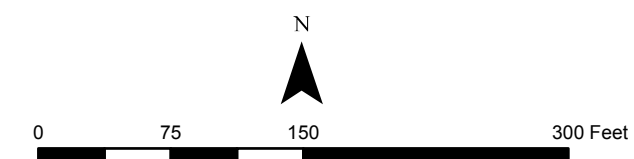


FIGURE A-1
Lower Aquifer Monitoring Well Sample Locations
Wyckoff/Eagle Harbor Superfund Site
Bainbridge Island, WA

Appendix B

Field Procedures

Field Procedures

This appendix provides detailed field procedures for completion of the Lower Aquifer Monitoring Program at the Wyckoff/Eagle Harbor Superfund Site. The purpose of the Lower Aquifer Monitoring Program is to characterize the general chemistry and the nature and extent of nonaqueous-phase liquid (NAPL) and dissolved phase contaminants present in Lower Aquifer groundwater within the Groundwater Operable Unit (OU) 4 portion of the Site. Data gathered as part of this study will be used to refine the conceptual site model (CSM) and to evaluate the effectiveness of the current containment remedy and future Upper Aquifer source control remedial actions. The rationale for the monitoring approach is described in the Quality Assurance Project Plan (QAPP) and associated data quality objectives ([Appendix A](#) in the QAPP).

B.1 Site Description

The Wyckoff/Eagle Harbor Superfund Site encompasses the contaminated areas of Eagle Harbor and adjoining uplands of the former Wyckoff wood-treating facility. The Site is divided into four OUs:

- **East Harbor OU1**—subtidal and intertidal sediments in Eagle Harbor adjacent to Wyckoff Point.
- **Soil OU2**—surface and unsaturated subsurface soil in the former Wyckoff wood treating process and storage area.
- **West Harbor OU3**—sediments and uplands of former shipyard.
- **Groundwater OU4**—groundwater and soil in the saturated zone beneath the Soil OU.

The Soil and Groundwater OUs comprise the approximately 19-acre area affected by releases of wood treating chemicals during the 85-year operating history of the Wyckoff facility. The Former Process Area (FPA) is an approximate 8-acre portion of the Soil and Groundwater OUs where wood treatment operations were primarily conducted and where large volumes of subsurface NAPL, including dense NAPL (DNAPL) and light NAPL (LNAPL) have been observed in wells and borings.

More information about the CSM and subsurface conditions in the Project Study Area is provided in [Appendix A](#) (Systematic Planning Summary and Data Quality Objectives Summary).

B.2 Project Overview

Dissolved phase contaminant of concern (COC) concentrations in Lower Aquifer groundwater have been measured since 1994. These measurements have been performed to assess the effectiveness of Upper Aquifer containment actions (sheet pile wall and groundwater pump-and-treat) to control or eliminate the transport of dissolved phase COCs from the Upper Aquifer to the Lower Aquifer. Additionally, Lower Aquifer groundwater monitoring field observations made in 2012 and 2014 indicate DNAPL may be present at five monitoring well locations.

B.2.1 Objectives

The objective of these field procedures is to provide instructions for gathering data supporting the Lower Aquifer Monitoring Program.

The objectives of this investigation are as follows:

- Determine NAPL presence, distribution and thickness in the Lower Aquifer.
- Characterize general water quality parameters for use in establishing potential potable and nonpotable water zones and evaluating water quality parameter spatial and temporal variations attributed to daily tidal variations.

- Measure dissolved-phase COC concentrations to assess the effectiveness of the containment remedy and establish a baseline for use in confirming no further degradation of the Lower Aquifer by planned source control actions to be implemented in the Upper Aquifer.
- Need to dispose of investigation-derived waste (IDW) properly.

B.2.2 Field Investigation Approach

This section provides information regarding the design of the groundwater monitoring program.

B.2.2.1 General Overview

The work activities associated with the groundwater monitoring program include the following:

- Collect field measurements of Lower Aquifer groundwater elevation, NAPL presence and thickness.
- Collect groundwater samples from Lower Aquifer wells for chemical analysis.

B.2.2.2 Rationale for Sample Locations

Proposed groundwater sampling locations are shown in [Figure B-1](#) and listed in [Table B-1](#) (tables are located at the end of this appendix). Sample locations are judgmental based on review of existing data relative to the data needs as described in [Appendix A](#) of the QAPP. [Table B-1](#) also shows Lower Aquifer monitoring well construction information.

Water Level and NAPL Measurement

Depth to groundwater and NAPL will be measured. Wells will be checked for the presence of LNAPL and DNAPL, and the NAPL thickness measured (if present). Based on well construction and the CSM for NAPL migration, it is assumed that only DNAPL (no LNAPL) would be present/detected in the Lower Aquifer wells.

- **Locations** - Groundwater elevation and NAPL measurements will be collected at the Lower Aquifer wells listed in [Table B-1](#) and shown on [Figure B-1](#).
- **Frequency** - Annually in July. Tide tables shall be consulted several months in advance of the sampling to confirm that the outgoing tide occurs during the daylight sampling window. Groundwater levels measured at all designated wells before sampling at any well, NAPL measured before groundwater purging/sample collection.

Groundwater Sampling

A subset of site monitoring wells screened in the Lower Aquifer were selected for groundwater sampling and analysis. The selection process was focused on monitoring wells that provide spatial coverage across the FPA footprint with a focus on the northern tip of the FPA where evidence of DNAPL and dissolved phase contamination has been observed in previous monitoring events.

- **Locations** - Seventeen Lower Aquifer wells are proposed for sampling. The selected wells are listed in [Table B-1](#), and well locations are displayed on [Figure B-1](#). As shown on [Figure B-1](#), several of these wells have installed water level transducers. The transducers shall be removed, if necessary, to allow for insertion of well purging/sampling equipment.
- **Frequency** - Annually in July. The tide chart for Eagle Harbor, Bainbridge Island, WA Station ID: 9445882 ([Station ID: 9445882](#)) shall be consulted several months in advance of the sampling to confirm that the outgoing tide occurs during the daylight sampling window. Monitoring wells at the northern perimeter of the site, where tidal influences are relatively stronger, will be sampled on a schedule corresponding to the outgoing and low tide period.
- The list of field and laboratory analytes is provided in [Table 2-1](#) of the QAPP.

B.2.3 Pre-event Planning

The following pre-event planning steps will be taken six weeks before the intended sampling:

- The CH2M Field Team Leader (FTL) shall assemble the project team (two teams recommended) and coordinate with the CH2M Project Chemist to complete the sample projections required by the EPA RSCC via submission of the draft QAPP and Analytical Services Request Form (ASRF). The sample projections include project sampling schedule, required analysis TAT, information on the number of wells to be sampled, including allowances for field duplicates, equipment blanks, and the analytes to be tested for each matrix. The EPA RSCC will assign the project a laboratory, project code, and sample numbers.
- Order all field equipment and conduct a readiness review with CH2M field staff to review sampling methods, sample management, IDW management, and health and safety requirements.

The following pre-event planning steps will be taken two weeks before the intended sampling:

- Prepare a sample collection schedule that lists the well sampling order and target purge and sample collection times to align with the outgoing tide cycle.
- Notify on-site operations personnel of the intended dates of sampling, sampling times, and sampling locations to ensure all wells are free of vegetation and readily accessible. Coordinate with on-site operations for temporary removal of transducers.
- For analyses to be performed by Tier IV laboratories, contact the laboratory to verify laboratory capacity at the intended receipt date and request sample containers, coolers, chain-of-custody (COC) forms, and sample labels.
- Inventory field supplies. Quantities of disposable items will depend on the number of wells sampled (17), the depth of the selected wells (depths are shown in [Table B-1](#)). All calibration solutions and field reagents must be checked to ensure that the expiration date has not passed. When the inventory check determines supplies are low, additional supplies should be ordered for shipment or pick up in time for the field event.
- Verify operation of field equipment. Equipment should be tested if it is seldom used, has malfunctioned in the past, or has been rented out. If tested equipment is in need of repair or replacement, the task should be taken care of in time for the field event.

The following pre-event planning steps will be taken one week before the intended sampling:

- Check sample containers to ensure that the proper number and type of containers, and preservatives are present ([Table B-2](#)).

The following pre-event planning steps will be taken two days before the intended sampling:

- Arrange for and ready transportation/field service vehicle.
- Review sampling procedures and site data in this document and from the last sampling event. Site data, including the monitoring well data, well sampling logs from the last event, and the site plan should also be reviewed.
- Review health and safety plan.

B.3 Field Documentation

This section describes the methods that will be used to document investigation activities for the Lower Aquifer monitoring program.

B.3.1 Project Communication

Daily progress reports will be submitted by the CH2M FTLs to the CH2M Project Manager (PM). Daily progress reports will include the work performed, problems identified and associated corrective actions taken, and other appropriate comments. To the extent possible, periodic progress reports will be submitted to EPA's Task Order Project Officer by CH2M HILL's PM during the field sampling event. Progress reports may include telephone conversations, emails, and/or memos or other written correspondence.

B.3.2 Sample Designation

A numbering scheme was developed that allows each exploration location to be uniquely identified and provides a means of tracking the sample from collection through analysis. The numbering scheme indicates the location and sample type. The unique sample identification will be entered in the field notebook, field tracking sheets, Scribe (designated in the Scribe program as the "Location"), and other records documenting sampling activities. The sample identification and sampling location will be recorded in the logbook and on the field forms provided in Attachment B-1. The identification system for exploration locations will have three components, as follows:

Well -MMYY

Where:

Well = Well Identification (for example, CW15)

MM = Month (for example, 07 = July)

YY = Year (for example, 16 = 2016)

Blind field duplicates (FDs) will be identified as FD and will be assigned sequential numbers for the sampling event (for example, FD1-0716). The field duplicate IDs and locations of the duplicates will be recorded in the logbook and on the field forms so that they can be cross-referenced. MS/MSDs will be labeled with the same Sample ID as the parent sample, with MS or MSD added at the end of the number. The Scribe primary sample identifier is the Region 10 sample number.

B.3.3 Field Documentation

The following sections provide information regarding field documentation procedures.

B.3.3.1 Field Forms

All sampling and associated activities will be documented on activity-specific field logs, where present. Standardized field logs will be produced to measure and record sample location, field parameter measurements, logging of digital photographs, and sample collection (see Attachment B-1 for field forms).

Individual sample information will be recorded into the Scribe software upon receipt of samples by the sample management personnel. The following fields will be filled out in Scribe and will be retained for future use:

- Project information including: Site name, case number, account code, project code.
- Sample information including: Sample number, date/time, matrix, collection, sample type, depth, analysis, container information, preservation, and Contract Laboratory Program (CLP) sample numbers.
- Shipping information including: Laboratory assignment with address and contacts, air bill information, COC number and any additional notes.

The procedures used for sample management will be consistent with the 2014 CLP Samplers Guide (EPA, 2014b) and the *Region 10 (R10) Quality Management Plan* (2014a) Requirements for documentation of locational, field monitoring, sample collection, project organization, labels, and COCs.

B.3.3.2 Field Logbook

Daily field activities will be documented through journal entries in a bound field logbook, which is dedicated to each field team for the sampling effort. Field logbook entry and custody procedures will follow National Enforcement Investigation Center policies and procedures of EPA. The field logbook will be water-resistant, and all entries will be made in indelible ink. The field logbook will contain all pertinent information about sampling activities, site conditions, field methods used, general observations, and other pertinent technical information. Language used will be objective, factual, and free of personal opinions. Hypotheses for observed phenomena may be recorded; however, they must be clearly identified as such and only relate to the subject of observation. Field logbooks will become part of the permanent project record. Examples of typical field logbook entries include the following:

- Personnel present

- Subcontractors' names and companies
- Time of arrival and departure at each site
- Daily temperature and other climatic conditions
- Field measurements, activities, and observations, including discussions resulting in pertinent field decisions
- Referenced sampling location description (in relation to a stationary landmark) and maps
- Sample collection methods and equipment
- Date and time of sample collection
- Types of sample containers used, sample identification and cross-referencing, sample types and preservatives used, and analytical parameters
- Quality control (QC) sample (duplicate or blank) sample location and sampling method
- Field instrument calibration information
- Documentation of equipment decontamination
- Site sketches and or reference to photographs taken
- Name, address, and telephone number of the contracted analytical laboratory
- Instrument calibration procedures and frequency
- Visitors to the site

The FTL or designee will be responsible for the daily maintenance of all field records. Each page of the field logbook will be sequentially numbered, dated, and signed by the person making the entry. Corrections to the field logbook will be made by using a single strike mark through the entry to be corrected, then recording and initialing the correct entry. For corrections made later, the date of the correction will be noted. Unused portions of the pages will be crossed out, signed, and dated at the end of each day.

B.3.3.3 Chain-of-Custody Procedures

Because samples collected during any investigation could be used as evidence, their possession must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. COC procedures should be followed to document sample possession as follows.

Definition of Custody

A sample is under custody if one or more of the following criteria are met:

- The sample is in a person's physical possession
- The sample is in a person's view after being in his or her physical possession
- The sample was in a person's physical possession and was then locked up or sealed to prevent tampering
- The sample is kept in a designated secured area

Field Custody

To collect samples for evidence, only enough material to provide a good representation of the media being sampled will be collected. To the extent possible, the quantity and types of samples and sample locations are determined before the actual fieldwork. As few people as possible should handle samples.

The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly.

The PM will determine whether proper custody procedures were followed during the fieldwork, and will decide whether additional samples are required.

Transfer of Custody and Shipment

Samples should be accompanied by a COC record. When transferring samples, the individuals relinquishing and receiving the samples should sign, date, and note the time on the record. This record documents custody transfer from the sampler, often through another person, to the analyst at the laboratory.

Samples should be packaged properly for shipment and dispatched to the appropriate laboratory for analysis with a separate COC record accompanying each shipping container (one for each field laboratory, and one for samples driven to the laboratory). Courier names and other pertinent information are entered in the “Received by” section of the COC record.

All shipments should be accompanied by the COC record identifying its contents. The original record and one copy should accompany the shipment to the laboratory, and a second copy will be retained by the PM.

Freight bills, postal service receipts, and bills of lading should be retained as part of the permanent documentation. A separate/unique Traffic Report/COC and airbill will be created for each cooler shipped, documenting the specific contents and location of the associated cooler.

Laboratory Custody Procedures

A designated sample custodian should accept custody of the shipped samples and verify that the sample numbers match those on the COC records. Pertinent information regarding shipment, pickup, and courier should be in the “Remarks” section. The custodian should enter the sample numbers into their LIMS.

The custodian will distribute samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received, until the sample is exhausted or returned to the custodian. The data from sample analyses should be recorded on the laboratory report form.

When sample analyses and necessary QC checks have been completed in the laboratory, the unused portion of the sample will be disposed of properly. All identifying sample tie tags, data sheets, and laboratory records will be retained as part of the documentation. Sample containers and remaining samples should be disposed of by the laboratory in compliance with all federal, state, and local regulatory requirements.

B.3.4 Sample Management

The following section discusses various sample management procedures that will be followed during the investigation. Included in these sections are procedures for sample packaging and transportation, sample labeling, and sample documentation. Sample volume, container, preservative and holding time requirements are listed in [Table B-2](#).

B.3.4.1 Sample Labeling and Containers

Each sample container will be labeled using labels generated with the Scribe software. One label will be attached to the sample container. The sample label will be completed using indelible ink and will include the following:

- R10 Sample number
- R10 Project Code
- Case number and CLP sample number (if applicable)
- Analysis requested (including specific constituents requested)
- Preservative used (“NA” if not applicable)
- Date and time of sample collection
- Sampler’s initials

Sample labels will be affixed to the sample containers and covered with clear packaging tape, then placed in a resealable bag. All sample numbers and locations (including blanks and duplicates) will be recorded in the field notebook and on individual sample information forms.

B.3.4.2 Sample Containers

After sample collection into a properly preserved container, the sample containers will be placed in re-sealable bags and stored in an ice-filled cooler for temporary storage prior to, and during, shipment to the laboratory. All samples will be packaged and labeled for shipment in compliance with current regulations.

B.3.4.3 Preparation of Sample Coolers

Only plastic ice chests will be used for shipping samples. The following steps will be followed to prepare sample coolers:

- All previous labels will be removed from the cooler.
- All drain plugs will be sealed with tape (inside and outside).
- A drum liner type large plastic bag is used to enclose all cooler contents.
- A cushioning layer of recyclable cornstarch popcorn or bubble wrap will be placed at the bottom of the cooler.
- If ice is used in the coolers for the laboratory, it will be placed in double, 1-gallon re-sealable bags.

B.3.4.4 Preparation of Sample Packing

The following steps will be followed for packing samples in coolers:

- The COC form will be placed in a resealable plastic bag.
- Samples will be placed in an upright position in the cooler.
- The void space between samples will be filled with recyclable cornstarch popcorn (or equivalent), double-bagged ice, or bubble wrap.
- Ice will be placed on top of and between the samples.
- The remaining voids will be filled with recyclable cornstarch popcorn (or equivalent) or double-bagged ice.

B.3.4.5 Sealing the Cooler

Coolers will be filled with packing material surrounding the bottles to prevent breakage during transport. Ice will be sealed in plastic bags to prevent melt water from soaking the packing material and compromising sample labels and integrity. Sample documentation will be enclosed in sealed plastic bags taped to the underside of the cooler lid. Coolers will be secured with packing tape and custody seals as follows:

- The cooler lid will be secured with strapping tape, encircling the cooler several times.
- Custody seals will be placed on two sides of the lid (one in front, and one on the side) and covered with tape to prevent inadvertent breaking of the seals.
- Arrows indicating "This Side Up" will be placed on the sides of the cooler.
- The shipping air bill will be securely attached to the exterior of the cooler.

B.3.4.6 Shipping the Cooler

The coolers will be shipped to the appropriate laboratory by overnight courier. If possible, samples will be shipped on the day of sample collection. Samples collected late in the day may be shipped on the following day.

The R10 RSCC must be contacted on the day of sample shipment and be provided the following information:

- Sampling contractor's name
- Site name and/or case number
- Total number(s) by concentration and matrix of samples shipped to each laboratory
- Carrier, air bill number(s), method of shipment (priority next day)
- Shipment date and intended laboratory receipt date
- Irregularities or anticipated problems associated with the samples

- Whether the current shipment is the final shipment or if additional samples will be shipped under the same case number

For Friday shipments, the Regional Sample Control Coordinator or subcontract laboratory must be contacted prior to noon Friday to coordinate sample shipments that will arrive on Saturday. Samples will only be shipped on Friday if the laboratory provides assurance that staff will be present to accept the samples.

The Scribe COC and related project files are submitted to the CLP and the RSCC in accordance with the R10 requirements on the day of sample shipment. This includes providing the RSCC with the COC .xml file and Scribe custom data view .xls file on the day of each shipment, as well as uploading the COC .xml file to the Sample Management Office Portal.

B.4 Sampling Equipment and Procedures

This section describes the required sampling equipment, procedures for equipment calibration, procedures for collection of groundwater samples and procedures for the collection of field data.

B.4.1 Field Equipment Needs and Calibration

The following equipment is expected to be used for collection of samples during the investigation:

- Groundwater sampling – peristaltic or Grundfos (or equivalent) 2-inch pump with dedicated tubing

The following equipment is expected to be used in the field to collect measurements:

- Flow through cell with water quality parameter probes. Used to measure groundwater temperature, salinity, pH, specific conductance, dissolved oxygen, turbidity, and oxidation-reduction potential “in-line” during purging without atmospheric contact. These measurements are used as an indicator of equilibrium prior to sample collection as well as for groundwater geochemical characterization.
- Water Level Indicator. Used to measure depth to water to the nearest 0.01 ft.
- Interface probe. Used to identify and measure NAPL thickness in monitoring wells to the nearest 0.01 ft to 0.05 ft.

Each of these instruments are checked and calibrated daily according to the manufacturer’s instructions; however, additional calibration checks may be carried out by the field team during the day if needed. Instrument adjustments will be made in accordance with procedures and schedules outlined in the particular instrument’s operations and maintenance manual. Calibration results will be recorded in the field notebook. Record calibration data on the “Field Instruments Calibration Documentation Form” ([Appendix B-1](#)).

Scheduled periodic calibration of testing equipment does not relieve field personnel of the responsibility of employing properly functioning equipment. If an individual suspects an equipment malfunction, the device must be removed from service and tagged so that it is not inadvertently used, and appropriate personnel notified so that a recalibration can be performed or a substitute piece of equipment can be obtained.

Equipment that fails calibration or becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment will be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

Results of activities performed using equipment that has failed recalibration will be evaluated. If the activity results are adversely affected, the results of the evaluation will be documented, and the PM and data users will be notified.

The following is a list of field equipment anticipated to be used for NAPL measurements and groundwater sampling:

- Field procedures

- Field logbook and forms
- Site maps
- Digital camera
- Health and safety equipment and applicable personal protective equipment (PPE)
- Calculator
- Dry erase white board and markers
- Weatherproof pens
- Pencil
- Permanent markers
- Garbage bags
- Plastic sheets
- Paper towels
- Decontamination supplies
- Nitrile gloves
- Rubber boots
- Sample coolers
- COC forms and sample container labels
- Ice
- Resealable plastic bags for sample containers (1-quart and 1-pint) and ice (1-gallon)
- Strapping tape
- Transparent tape
- Shipping airbills
- Measuring tape
- Multi-parameter (groundwater temperature, salinity, pH, specific conductance, dissolved oxygen, turbidity, and oxidation-reduction potential) probe
- Multi-parameter probe calibration solutions
- 5-gallon buckets
- Scissors
- All equipment associated with groundwater sampling (peristaltic pump, head tubing, sample tubing)

B.4.2 Groundwater Level and LNAPL Thickness Measurements

Groundwater level and LNAPL thickness measurements will be collected at all wells listed in [Table B-1](#) before groundwater sampling activities begin. The measurements will be collected within 1.5 hours of low tide, in as short of timeframe as possible preferably the day before sampling begins, beginning with the wells nearest the shoreline and progressing inland to minimize the effects of tidal influence on the data set. Groundwater level measurements consist of depth-to-water measurements from the surveyed measuring point (generally the top of the well casing) at each well. Depths will be measured and recorded to the nearest 0.01 foot. Although LNAPL is

not expected in the Lower Aquifer wells, instructions for measuring LNAPL thickness are included. DNAPL and well depth measurements will be collected as part of the sampling procedures (Section B.4.3).

The following procedures will be used to measure groundwater level and LNAPL thickness:

- Decontaminate the interface probe and water level indicator and perform operational check.
- If the well is sealed with an airtight cap, allow time for pressure to equilibrate after the cap is removed before measuring fluid levels.
- For LNAPL, measure the depth to the air/product interface on the way down, and the water/NAPL interface on the way up. When passing through product into water, some product may adhere to the probe sensors due to surface tension. Therefore, when water is detected below LNAPL, the probe should be raised and lowered rapidly in a short vertical motion to remove any product that may be carried down with the probe.
- Measure the water/LNAPL interface as the probe is raised very slowly back up. Once the interface is detected the probe can be raised and lowered in small increments to precisely determine the interface. Measure to the nearest 0.01 foot.
- Repeat measurements to confirm water/LNAPL interface.
- Calculate the thickness of product (subtract the water/LNAPL interface depth from the LNAPL/air interface depth). Record the LNAPL depth and thickness (if present) and depth to water.
- Record results on the Groundwater Sampling Data Sheet (Attachment B-1).

B.4.3 Groundwater Sampling Procedures

These groundwater sampling procedures are applicable for the wells listed in [Table B-1](#).

B.4.3.1 Monitoring Well Purging, Sampling, and DNAPL Thickness

Groundwater sampling will be performed consistent with low-flow/low volume methods used to collect previous Lower Aquifer samples. Sampling will include groundwater low-flow (less than 500 mL/min) purging and parameter stabilization (if feasible) prior to sampling to obtain a representative groundwater sample. Sampling procedures will minimize the potential for entrainment of solids or NAPL in the groundwater samples. Visible NAPL droplets, sheen, or high turbidity in the groundwater samples could result in biased-high results and shall be avoided, if possible.

Groundwater purging and sampling will be performed using a peristaltic pump and 0.25-inch or 0.375-inch diameter polyethylene suction tubing set near the mid-point of the screen. New, disposable, factory-packaged polyethylene tubing will be used for each sample location and will be disposed following the sampling event. If LNAPL is detected at the top of the water column prior to sampling, additional sample procedures (described after steps 1 through 17) shall be used to prevent entrainment of LNAPL in the sampling equipment train.

1. Purging and sampling procedure will be documented on sampling forms (shown in [Attachment B-1](#)) and consist of the following:
2. Lower decontaminated water-level probe into the well to measure water levels during well purging. Water level measurements will be used to verify minimal drawdown conditions, assess water level stabilization, and prevent dewatering of the well.
3. Connect an appropriate length of polyethylene suction tubing to one end of an approximately 8- to 12-inch piece of viton tubing. Connect the other end of the viton tubing to a 3- to 4-foot piece of polyethylene discharge tubing. Try and minimize the length of sample tubing whenever possible to reduce turbulence and aeration during pumping.
4. Lower the end of the polyethylene suction tubing to the center of the well screen.
5. Insert the 8- to 12-inch viton tubing section into the peristaltic pump head and lock the tubing within the pump head. Connect the other end of the discharge tubing to the in-line flow cell's "IN" fitting. Connect a sufficient length of new polyethylene tubing to the in-line flow cell's "OUT" fitting, and clamp this tubing to a purge bucket in a manner that discharging groundwater will flow into the bucket.
6. Connect the peristaltic pump directly to the generator (or battery if available) using an extension power cord.

7. Place the generator (if used) downwind of the sampling area. Make sure that the generator supplying power to the pump is sufficiently fueled before sampling.
8. Turn on the pump. Measure the flow rate using a graduated cylinder or other appropriate vessel. Verify the purge rate that is consistent with micropurging methods (generally less than 500 mL/min and minimal drawdown).
9. After a single flow cell's volume has been adequately purged, read and record depth to water and water quality field measurements until all parameters have stabilized within their allowable ranges for at least three consecutive measurements. Stabilization is defined as follows:

- ± 1.0 °C temperature
- ± 0.1 pH
- $\pm 3\%$ conductivity
- ± 10 millivolts (mV) ORP
- $\pm 10\%$ dissolved oxygen
- $\pm 10\%$ turbidity or ≤ 10 NTUs

Stabilization of salinity prior to sample collection is not required. The frequency of readings will be based on the time required to purge one volume of the flow cell. For example, a 500-mL flow cell purged at a rate of 250 mL/min will be purged in two minutes, so readings should be at least two minutes apart. Record any odor, color, sheen or other parameters identified in the Well Purge and Groundwater Sampling Sheet. When stabilization has been achieved, sample collection may begin.

10. To collect the sample, disconnect the flow cell and it's tubing from the pump discharge line before collecting samples. Samples, as applicable, should be collected in the following sequence for each well: polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), and then general chemistry parameters.
11. Samples for dissolved iron and manganese, shall be taken last, shall be collected by attaching a 0.45 micron inline filter to the pump discharge tubing. The filter shall be purged with well water for 15 to 30 seconds before collecting water in the sample container. Do not overfill the sample container if it has been pre-preserved. A new filter is used at each well location. Filtration will occur within 15 minutes of collection.
12. When all sample containers have been filled, make a final measurement of the depth to water and record the measurement.
13. Turn off the pump. Disconnect the cables from the battery terminals.
14. Measure and record the total purge volume collected.
15. Remove all applicable tubing from the well and flow through cell.
16. Collect DNAPL and well depth measurements at each well. Lower the interface probe through the water column slowly to check for DNAPL. If a steady tone occurs, the instrument has detected DNAPL. Measure the depth on the measuring tape. Continue lowering the probe until the bottom of the well is reached (tape slackens). Measure and record the DNAPL depth and thickness (if present) and the well depth. If it can be determined, record whether the bottom of the well "feels" soft (indicating sediment) or solid. Depths will be measured from the surveyed reference mark on the wellhead to the nearest 0.01 foot. Record results on the Groundwater Sampling Data Sheet (Attachment B-1). After recording the measurements, retract the interface probe while wiping it down with a disposable towel.
17. Decontaminate the water level probe and interface probe. If an in-line flow cell was used, clean and decontaminate this equipment.
18. Dispose of the polyethylene and viton tubing
19. Secure the wellhead cover.

Alternate methods may be employed if approved by the PM. Secondary methods may include use of bladder-type pump. Use of a bailer for well purging may not be acceptable.

Special Procedures for wells with LNAPL

If the LNAPL is detected at the top of the water column prior to sampling, the well will be purged and groundwater samples collected using a stilling tube (for example, a small diameter PVC pipe) and new sample tubing. The goal is to sample the groundwater while preventing the LNAPL from entering the sampling device. The stilling tube will be inserted into the well to a depth that allows ground water from the screened interval to be purged and sampled, but that is below the upper portion of the screened interval where the LNAPL is entering the well screen. The end of the stilling tube will be covered with a membrane (for example, piece of tape, aluminum foil, or other compatible material that can be punctured by the sample tubing. The membrane must be taped to the outside of the stilling tube such that it is removed from the well when the stilling tube is removed. Lower the tube slowly into the well to the appropriate depth and then attach firmly to the top of the well casing. Break the temporary membrane covering the end of the tube with the sample tubing, then purge and sample from below the LNAPL layer following the procedures in Section B.4.3.1. The stilling tube should be decontaminated prior to each use.

B.4.4 Field Quality Control Samples

QC samples collected in the field will be used to assess the overall quality of the project data. Field QC samples will include FDs, MS/MSD, equipment rinsate blanks, filter blanks, and temperature blanks.

B.4.4.1 Field Duplicate Samples

Field duplicate samples will be collected to assess the homogeneity of samples collected in the field and the precision of the sampling process. Field duplicates will be prepared by collecting two aliquots of sample from the sampling equipment and submitting them for analysis as separate samples. Field duplicates will be collected from at least 10 percent of the sampling locations. Duplicate samples are indicated as field duplicates in the Scribe Sample Type field. Analyses will be the same as those required for the parent sample.

B.4.4.2 Equipment Rinsate Blank

Equipment rinsate blanks and 0.45 micron filter blanks are used to evaluate sampling device cleanliness and potential carryover of target contaminants from equipment contribution. Equipment rinsate blanks are collected after a sample collection device (for example, a portable submersible pump) is subjected to standard decontamination procedures. American Standard for Testing and Materials Type II water (purchased and certified from a commercial vendor) will be poured over or through the sampling device and collected in a sample container for analysis. One equipment rinsate blank will be collected for each sample train type per event. If a rented (e.g. pump) and/or new sample tubing (e.g. suction and discharge) are used, the sample shall be collected by pumping the Type II water through the entire sample train. If dedicated suction/discharge tubing and a rented pump are used, the sample shall be collected by pumping or pouring Type II water through the pump only. Field Blanks are indicated in the Scribe Sample Type field.

B.4.4.3 Temperature Blanks

All coolers shall contain at least one temperature blank. The temperature blank should be a 40-milliliter volatile organic analysis vial filled with water and placed in a representative position inside the cooler. Each vial shall be clearly marked "TEMPERATURE." If the temperature blank is positioned inappropriately or is not representative of the cooler temperature measurement, the project laboratory shall document the deficiency and notify the Project Chemist.

B.4.4.4 Matrix Spike/Matrix Spike Duplicates Samples

MS/MSD analyses will be performed in the laboratory to assess the accuracy of the analyses. These analyses will be performed according to the laboratory protocols and will occur at a frequency of once every 20 samples using extra volumes of sample matrices collected in the field. MS/MSD samples will be designated as such in Scribe and on the COC form. Analyses will be the same as those required by the parent sample.

B.4.5 Equipment Decontamination

Sampling equipment must be decontaminated consistently to ensure the quality of the samples collected. All equipment that comes into contact with potentially contaminated samples will be decontaminated. Temporary decontamination stations and related containment will be established near the work areas as needed. Reusable sampling equipment such as water level indicators and interface probes will be decontaminated prior to use and in between each sample to reduce the potential for cross-contamination. New disposable nitrile gloves will be worn when handling clean sampling equipment to ensure that the equipment is not contaminated. Equipment decontamination procedures are as follows:

- Remove large particles or NAPL from equipment by wiping (with paper towel) or brushing off, as appropriate
- Wash with solution of tap water and non-phosphate detergent (such as Alconox)
- Rinse with tap water
- Double rinse with deionized water

Disposal equipment intended for one-time use that is factory-wrapped generally does not need to be decontaminated before it is used unless there is evidence of contamination present. All one-time use, disposable sampling equipment and accessories will be discarded once used, and a new set of equipment will be used for each subsequent sample.

The field representative will maintain a record of the types and quantities of IDW that are generated at each sample location.

B.4.6 Containment and Disposal of Investigation-Derived Wastes

Purge water will be placed in the secondary containment pads and transferred to the decontamination pad or other sump connected to the on-site treatment plant for reprocessing in the plant.

Decontamination fluids will be placed in the secondary containment pads and transferred to the decontamination pad or other sump connected to the on-site treatment plant for reprocessing in the on-site treatment plant.

All PPE and disposable equipment (such as nitrile gloves, sample tubing, and paper towels) will be placed in garbage bags and transferred to designated, labeled drums located at the on-site hazardous waste storage area. The drummed refuse materials will be managed as Hazardous Waste for off-site disposal.

TABLE B-1
Lower Aquifer Groundwater Monitoring Sample Locations and Descriptions

Selected Well	Monitor Well Coordinates ^a				Land Surface Elevation (feet MLLW)	Top of Casing Elevation (feet MLLW)	Well Screen Interval (feet bgs)	Sump Length (feet)	Well Depth (feet bgs)	Well Screen Interval (feet below top of casing)	Well Depth (feet below top of casing)	Well Diameter (inches)	DNAPL Thickness Measurement	Groundwater Sample Collected
	North Latitude	West Longitude	Northing	Easting										
02CD-MW01	47.6165327	-122.500726	229347.26	1229207.66	16.13	18.01	53 - 63	0	63	54.9 – 64.9	64.9	2	No	No
99CD-MW02A	47.6170085	-122.501104	229522.80	1229118.20	14.82	16.72	72.5 – 82.5	0	82.5	74.4 - 84.4	84.4	2	Yes	Yes
99CD-MW04A	47.6167327	-122.500986	229421.60	1229145.10	16.18	18.17	66 - 76	0	76	68 - 78	78.0	2	No	No
CW01	47.6152416	-122.501077	228878.30	1229110.82	59.04	61.12	52 - 62	3	65	54.1 – 64.1	67.1	4	No	No
CW02	47.6162749	-122.49973	229247.94	1229451.11	17.17	19.60	67 - 77	3	80	69.4 - 79.4	82.4	4	No	Yes
CW05	47.6176122	-122.501253	229743.74	1229086.06	15.93	18.45	89 - 99	3	102	91.5 - 101.5	104.5	4	Yes	Yes
CW09	47.6171045	-122.500322	229553.63	1229311.81	15.56	17.94	95 - 105	3	108	97.4 - 107.4	110.4	4	Yes	Yes
CW12	47.6166979	-122.501314	229410.66	1229063.78	16.39	18.79	55 - 65	3	68	57.4 – 67.4	70.4	4	No	No
CW15	47.6175654	-122.500942	229725.01	1229162.53	14.46	16.48	85 - 95	3	98	87.0 - 97.0	100.0	4	Yes	Yes
P-1L	47.6165637	-122.499702	229353.08	1229460.41	16.69	19.54	85 - 95	2	97.0	87.9 – 97.9	99.9	2	No	Yes
P-2L	47.6171768	-122.500014	229578.35	1229388.11	17.07	19.84	102.6 – 112.6	2	114.6	105.4 - 115.4	117.4	2	Yes	Yes
P-3L	47.6177885	-122.50075	229805.34	1229211.56	20.20	23.17	110.4 – 120.4	2	122.4	113.4 - 123.4	125.4	2	Yes	Yes
P-4L	47.6175815	-122.501693	229734.92	1228977.33	17.88	20.74	78.8 – 88.8	2	90.8	81.7 – 91.7	93.7	2	Yes	Yes
P-5L	47.6170702	-122.502261	229551.50	1228833.35	19.03	20.74	68 - 78	2	80.0	69.7 - 79.7	81.7	2	Yes	Yes
P-6L	47.6165904	-122.502999	229380.46	1228647.66	17.58	20.75	75 - 85	2	87.0	78.2 - 88.2	90.2	2	No	Yes
PZ-03	47.6156641	-122.499839	229025.75	1229419.38	18.14	20.01	20 - 30	2	32	21.9 – 31.9	33.9	2	No	No
PZ-05	47.6156576	-122.500446	229026.65	1229269.77	20.60	22.24	3 - 8	2	10	4.6 – 9.6	11.6	2	No	No
PZ-08	47.6156442	-122.501702	229028.47	1228959.80	17.99	19.92	15 - 25	2	27	16.9 – 26.9	28.9	2	No	No
PZ-09	47.6156245	-122.502109	229023.44	1228859.27	18.16	19.89	15 - 25	2	27	16.7 – 26.7	28.3	2	No	No
PZ-10	47.6156256	-122.502513	229026.02	1228759.64	18.25	20.10	15 - 25	2	27	16.9 – 26.9	28.9	2	No	No
PZ-11	47.6156265	-122.502932	229028.60	1228656.36	18.23	20.13	15 - 25	2	27	16.9 – 26.9	28.9	2	No	Yes
PZ-12	47.6156208	-122.503322	229028.59	1228560.33	18.00	19.88	15 - 25	2	27	16.9 – 26.9	28.9	2	No	No
SE-02	47.6158915	-122.499575	229107.30	1229486.19	16.88	18.98	38.1 – 48.1	2	50.1	40.2 – 50.2	52.2	2	No	No
VG-1L	47.6169102	-122.500141	229481.82	1229354.71	15.97	18.96	88.5 – 98.5	2	100.5	91.5 - 101.5	103.5	2	No	Yes
VG-2L	47.6175692	-122.500378	229723.40	1229301.66	23.24	26.17	114.7 – 124.7	2	126.7	117.6 - 127.6	129.6	2	Yes	Yes
VG-3L	47.6173239	-122.501726	229641.15	1228967.28	19.96	22.82	85.4 – 95.4	2	97.4	88.2 - 98.2	100.2	2	Yes	Yes
VG-4L	47.6168258	-122.502316	229462.66	1228817.70	18.14	20.73	75 - 85	2	87.0	77.6 - 87.6	89.6	2	No	Yes
VG-5L	47.6164847	-122.501682	229334.88	1228971.53	16.21	18.98	60.6 – 70.6	2	72.6	55.3 - 65.3	75.3	2	No	Yes

Sample locations are shown on [Figure B-1](#).
Shaded = not sampled.
^a Latitude and Longitude provided in decimal degrees. Washington State Plane Coordinates based on: NAD 83/91, Washington North Zone, US Survey Feet/
bgs below ground surface

TABLE B-2
Analytical Summary –Groundwater

Matrix	Analytical Group	Analytical and Preparation Method	Containers	Preservation	Maximum Holding Time	Number of Samples	Number of Field Duplicates	Number of MS/MSD	Equipment Blanks ^d	Total Analyses
Groundwater obtained from monitoring wells	Total dissolved solids (TDS)	SM2540C	250 mL HDPE	<6°C	7 days	17	2	1 ^c	5	25
Groundwater obtained from monitoring wells	Alkalinity	SM2320B	1-liter HDPE	Cool <6°C, minimize headspace	14 days	17	2	1	5	25
Groundwater obtained from monitoring wells	Sulfate and Chloride	EPA 300.0	250 mL HDPE	Cool <6°C	28 days	17	2	1	5	25
Groundwater obtained from monitoring wells	Nitrate+Nitrite as N	EPA 353.2	1-liter HDPE	H2SO4 to pH<2, <6°C;	28 days	17	2	1	5	25
Groundwater obtained from monitoring wells	Total Metals ^a	EPA 6010B or CLP SOW	500 mL HDPE	HNO3 to pH<2	180 days	17	2	1	5	25
Groundwater obtained from monitoring wells	Dissolved Metals ^b	EPA 6010B or CLP SOW	500 mL HDPE	HNO3 to pH<2	180 days	17	2	1	5	25
Groundwater obtained from monitoring wells	Semivolatile organic compounds (PAHs and PCP)	EPA 3535A +8270D MS-MS or CLP SOW	2-1 liter Glass, Teflon lined cap ^e	Cool <6°C	7 days until extraction and 40 days after extraction	17	2	1	5	25
Groundwater obtained from monitoring wells	Salinity pH Conductivity Dissolved oxygen Redox Potential Temperature depth to water depth to NAPL (if present)	Field multi-probe meter	Not Applicable	Not Applicable	Not Applicable	17	2	Not Applicable	Not Applicable	19

Notes:

^a Total Metals (Calcium, Iron, Magnesium, Manganese, Sodium, and Potassium)

^b Dissolved Metals (Iron and Manganese). Dissolved water samples are filtered at 0.45 micron filter within 15 minutes of collection.

^c Only laboratory duplicate performed for this analysis

^d Includes one sample per batch of new pumping tubing and one sample per batch of 0.45 micron filters per event. The total number of equipment blank samples could range from 2 to 5 per event depending on actual number and types of sampling trains used.

^e 8-1 liter glass, Teflon lined cap containers required for designated laboratory QC samples

Figure



LEGEND

- Lower Aquifer Well
- Fence
- Sheetpile Wall
- Roads
- Buildings
- Concrete Slab
- Structures
- * Vertical Gradient Monitoring Location
- Wells Identified for Annual Sampling Beginning in 2016
- Wells Identified for Annual Sampling Beginning in 2016 where DNAPL was Observed in 2012/2014

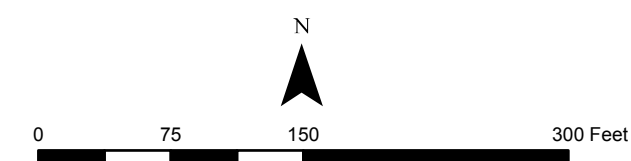


FIGURE B-1
Lower Aquifer Monitoring Well Sample Locations
Wyckoff/Eagle Harbor Superfund Site
Bainbridge Island, WA

Attachment B-1
Field Forms

Field Instruments Calibration Form

Wyckoff Superfund Site - Bainbridge Island, Washington

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time
Water Quality						
Calibrated to Autocal Solution Manufacturer _____ Lot Number _____ Autocal Solution pH = Turbidity = Conductivity =						
Calibration Readings pH = Turbidity = Temperature = Conductivity = Dissolved Oxygen = Salinity =						
Comments:						

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time
Water Quality						
Calibrated to Autocal Solution Manufacturer _____ Lot Number _____ Autocal Solution pH = Turbidity = Conductivity =						
Calibration Readings pH = Turbidity = Temperature = Conductivity = Dissolved Oxygen = Salinity =						
Comments:						

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time
Water Quality						
Calibrated to Autocal Solution Manufacturer _____ Lot Number _____ Autocal Solution pH = Turbidity = Conductivity =						
Calibration Readings pH = Turbidity = Temperature = Conductivity = Dissolved Oxygen = Salinity =						
Comments:						

Groundwater Sampling Data Sheet

Wyckoff Superfund Site - Bainbridge Island, Washington

Well ID		Date	
Sample ID		Field Team Initials	
EPA Sample Number			
Field Conditions			

Purge Information

Well Diameter (in.)		Purge Method (circle) :	<i>Submersible Pump</i> <i>other:</i> <i>Bladder Pump</i> <i>Peristaltic Pump</i>
Well Depth (ft.)			
Initial Depth to Water (ft.)		Water Level Indicator # _____	
Depth of Water Column		Pump Indicator # _____	
3 Casing Volumes			Start Time
1 Casing Volume			End Time
			Total Gallons Purged
Sample Depth (ft. below TOC)			Purge Rate
Well Screen Interval (ft below TOC)		to	
			Controller Frequency

Time	DTW	Gallons Purged	pH	Conductivity	NTU	DO	Temp.	ORP	Salinity	Appearance

Sample Information

Sample Method(s) (circle): Bladder pump Peristaltic pump Submersible Pump other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments

End Time


Comments / Exceptions:

Presence of floating product? Yes/No

Describe appearance and amount

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.
 Stabilization Parameters are shown in **BOLD**
 Check for floaters and sinkers and enter observations under comments section.

Appendix C
Site-Specific Data Management Plan

	Site-Specific Data Management Plan			
	Project Name:	Wyckoff Lower Aquifer GW Monitoring	TDD Number/Site ID:	EPA ID: WAD009248295
	Author:	CH2M	Sampling Company:	CH2M HILL
	Date Initiated:	May 12, 2016	Last Updated:	July 1, 2016
	QAPP(s) covering sampling at the site:		Quality Assurance Project Plan, Wyckoff/Eagle Harbor Superfund Site, Lower Aquifer Groundwater Monitoring(<i>Final</i>)	

This data management plan (DMP) is intended to provide guidance for data collection by field personnel during Lower Aquifer Groundwater Monitoring. The Region 10 Data Management Plan acts as a reference guide for this project. All site specific data requirements are considered a sub-set of that region wide DMP. The comprehensive field data deliverable will be a Scribe project managed by the CDM Field team, this project should be published to Scribe.NET daily when field activities are in progress and upon data import after each event. At the conclusion of each sampling event, the .bac file will be delivered to the R10 RSCC. Once all the validated laboratory data has been uploaded to Scribe the completed Scribe project file will be published / archived to Scribe.net.

Data Processing

The following table outlines the specific requirements for various data types being collected during the project.

	Data Input	Data Stream	Data Provider	Target Database	Site Specific Data Elements	Site Specific Verification	Site Specific SOP
1	Alkalinity (bicarbonate and carbonate)	Lab Results	CH2M Data Manager	Scribe	None	No	No
2	Site Information	Site Info	EPA RSCC, CH2M Scribe Manager	Scribe	None	Yes, R10 Auditor Rules	No
3	Anion/Cation Balance	Lab Results	CH2M Data Manager	Scribe	None	No	No
4	Sample Location Spatial Data	Sample Location, Spatial Data	CH2M Scribe Manager	Scribe	None	Yes, CH2M field data QA/QC	No
5	Groundwater field measurements	Water quality monitoring records	CH2M Field Team	Scribe	None	Yes, CH2M field data QA/QC	No
6	Groundwater Analytical	Lab Results	EPA RSCC, CH2M Data Manager	Scribe	None	Yes, R10 Auditor Rules	No

Reporting

	Reporting Task	Data Inputs	Transformation SOP	Deliverable Format(s)	Frequency
1	Groundwater depth measurements	Used to calculate groundwater elevations and prepare groundwater elevation contour and flow maps	No	Excel spreadsheet, GIS maps, Scribe	Completion of each field event (multiple events planned)
2	Alkalinity, pH, anions, cations	Calculate anion/cation balance and assess saltwater presence/absence in groundwater samples.	No	Excel spreadsheet, Scribe	Completion of each field event (multiple events planned)
3	LNAPL and DNAPL thickness measurements	Evaluate NAPL migration	No	Excel spreadsheet, Scribe	Completion of each field event (multiple events planned)
4	Groundwater analytical laboratory data	Evaluate dissolved-phase contaminant migration	No	Excel spreadsheet, Scribe	Completion of each field event (multiple events planned)

c